

Módulo 6: Operações de Frete, Intermodais e de Veículos Comerciais

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Propósito

The purpose of this module is to illustrate and explain major intelligent transportation systems (ITS) applications related to commercial highway vehicle operations, including highway and intermodal interfaces of air, ocean, or rail intermodal freight. This module also shows how these applications deliver operating efficiencies, customer service quality improvements, better safety, improved enforcement, and greater security assurance, as well as how different ITS technologies and architectures relate to those benefits. Readers should gain an appreciation of what has been tried and proven and, in many cases, what the outcomes of those trials have been. This module should give both students and practitioners a better understanding of how such technologies can be used to improve freight transportation.

Objetivos

This module has five objectives. Overall, the module gives readers a context—a background in private sector freight transportation and how its use of ITS technologies relates to the public sector. Freight transportation is a private business that involves moving cargo from one private company to another. The public sector sometimes has an interest in freight transportation as a shipper, but its interest is usually related to its role as a regulator or a policymaker and provider of common-use infrastructure, such as roads. When exploring the inter-relationships between the private and public sectors in the freight transportation realm, the five objectives are as follows:

- Understand the different yet complementary goals of private and public sector applications of ITS freight technologies.
- Describe public, private, and public-private examples of ITS freight applications.
- Describe the types of ITS benefits delivered to different stakeholders.
- Show how and why private and public sector ITS applications gravitated toward different technologies and communications architectures (applications based on vehicle-centered, long-range communications vs. infrastructure-oriented, vehicle-to- roadside communications).
- Identify resources that readers can use to increase their understanding of ITS

freight applications.

Introdução

ITS applications for intermodal freight and commercial vehicle operations sit at the intersection of commercial interests, economic productivity, public safety, and security; they cover goods movement by all surface modes, including their interfaces with air and ocean modes. This module highlights public and private sector ITS applications used in commercial vehicles, freight transportation infrastructure, and freight management.

Setting the Stage: Overview of Freight Functions and Issues

Efficient transportation of domestic and international freight (shipments of raw materials and intermediate and finished goods) is vital to the U.S. and world economies. While this module focuses on ITS technologies in freight transportation, readers may look to the Department of Transportation's (DOT) Federal Highway Administration's (FHWA) *Freight Facts and Figures* for comparative statistics showing the impact of transportation on the economy, its growth in the last several decades, and the distribution of freight among the various transportation modes.¹

Freight industries and their customers use information technologies (IT) and telecommunications to improve the efficiency and productivity of their freight movements, increase global connectivity, and enhance freight system security against common threats and terrorism. The surface freight industries include motor carriers, railroads, ocean carriers, and barge companies on the inland waterways.²

IT and telecommunications technologies help the freight transportation system operate more intelligently to improve the efficiency and reliability of cargo delivery. Most important, they do so in ways that improve safety, whether related to hazardous materials transport, heavy truck maintenance, or load-limit compliance. Safety improvements affect not only freight vehicle operators, other drivers, and the public with whom the freight vehicles interact in the transportation system, but also property (including cargo and the structures and equipment along transportation corridors). Efficiency, reliability, return on investment to freight transportation companies, and opportunities to enhance safety for operators and cargo are driving forces behind the adoption of new technologies in the commercial freight industry.

A number of Federal agencies have interests in and interactions with the freight transportation industry. DOT agencies that interact with the freight sector include FHWA, the Federal Motor Carrier Safety Administration (FMCSA), the Maritime Administration (MarAd), the Pipeline and Hazardous Materials Safety Administration (PHMSA), and the Federal Railroad Administration (FRA). The Department of Homeland Security (DHS) and its Transportation Security Administration (TSA) and Customs and Border Protection (CBP) play important roles in freight security and international trade.

While all of the above agencies have an interest in freight information technologies, DOT's FHWA and Joint Program Office (JPO) have worked collaboratively with private industry to identify technologies that meet common goals and then have supported field tests and evaluations. The technologies relate to applications such as:

- Intermodal truck-ocean, truck-rail, rail-ocean
- Intermodal terminals and congestion issues
- CVO clearance, compliance, and safety
- Homeland and cargo security

Capabilities that Private Industry Stakeholders Want from ITS₃

- Increase return on investment through enhanced efficiencies and cost savings
- Improve planning for the acquisition and distribution of material goods
- Support the purchase, scheduling, and rescheduling of required transportation services
- Identify freight items and packages, pallets, and shipping containers to permit comprehensive in-transit visibility by carriers to benefit their own operations and their customers
- Improve the information flow throughout the supply chain
- Support supply chain performance evaluation and continuous improvement

Freight roles and relationships. The essential players in freight transportation are the shipper, the carrier, and the consignee.⁴ Shippers tend to be manufacturers, wholesalers, or retailers. They originate freight shipments which may be high in value, in number of shipments, or in size of shipments; timeliness, accuracy, and completeness of shipment delivery are usually crucial to the success of their businesses. Shippers buy carriers' services. Carriers perform transportation operations and sell transportation services. Carriers (such as truck fleets) may be independent firms that provide "for hire" services or private fleets that are part of larger businesses that ship or receive cargo. Consignees receive shipped items. As with shippers, consignees may be manufacturers, wholesalers, or retailers; shippers and consignees may even be parts of the same firm.

Shippers, carriers, and consignees are critically interested in the quality (the accuracy, timeliness, and completeness) and accessibility of information about shipments and transportation operations. With recent revolutions in IT and telecommunications, the old saying that the information is as important as the cargo is more valid now than ever. The information is valuable in at least two contexts: first, in terms of business logistics and supply chain management (with respect to physical distribution, customer satisfaction, and cash flows); and second, with ITS, because of the intimate connection between the movements of goods and the efficiency and broader impacts of transportation networks.

Background of Freight ITS

ITS goals and applications: private vs. public sector. Contemporary freight ITS

programs weave together two very different backgrounds. To increase profits, the private

sector (especially long-haul truck operators) led the way with then-revolutionary ITS technologies and tools. The public sector began more gradually, oriented toward public safety and efficiency for regulatory compliance, toll collection, and public interests such as energy use and air quality.

Early adopters in the private sector looked toward IT and telecommunications innovations to support their business objectives. Innovation occurred in almost all freight sectors, as managers and owners, shippers, carriers, and consignees looked for ways to become more efficient (deliver the same or more services with fewer resources) and more reliable (delivering goods in good condition, to the correct destination, and on schedule). “Intelligent Transportation Systems” was not part of their vocabulary, but their actions were consistent with ITS concepts.

Not all progress resulted from careful analysis and detailed planning. Perhaps the greatest leap in trucking efficiency and profitability was a spin-off from a marketing experiment. At the end of the 1980s, a major electronics and microchip company developed integrated satellite location determination and fleet management telecommunications technology for the trucking industry. This seemed like rocket science for trucking, and the supplier needed an early adopter. A leading non-scheduled, privately-held truckload common carrier decided to take a flyer on the satellite tracking service, figuring “even if it did not work very well, it would be a good marketing tool with customers.”⁵

The tracking technology exceeded all of the carrier’s goals, yielding significant benefits in operating efficiencies, customer service, driver satisfaction, and truck maintenance management. This intelligent transportation system was such a great success because it combined a digital feed of a vehicle’s actual location that the carrier’s engineers tied together in its IT systems with customer shipment requests, over-the-road driver interests in maximizing loaded revenue miles and coordination of schedules with family commitments, maintenance management, and customer support systems. Expense ratios dropped, empty- to-loaded mile ratios plummeted, and driver turnover (a big industry problem) shrank. In addition, customers noticed the difference in the quality and reliability of the carrier’s services. An author of this module learned about the carrier’s improved performance in the early 1990s from a shipper who commented on the carrier’s ability to beat every other carrier in on-time deliveries.⁶

The public sector ITS program began to crystallize in the early 1990s, and the term ITS gained currency in the late 1990s.⁷ The public sector’s CVO umbrella covered freight movement, carrier operations, and vehicle operations, but more emphasis went toward applications related to safety assurance, credentials administration, and electronic screening. Those areas included public sector regulatory responsibilities to ensure freight vehicle safety, preservation of public roadway investments against overloaded trucks, and triage of commercial vehicles to ensure most effective use of enforcement resources.⁸

Public sector ITS CVO programs were aimed at efficiency in the use of public resources and in public sector demands on commercial vehicle personnel's time. Toll collection via radio-frequency identification (RFID) tags reduced labor for public agencies and saved time for all vehicle drivers and passengers. More elaborate RFID applications facilitated electronic screening and credentials administration. With the turn of the century, more public sector emphasis shifted to using ITS applications to mitigate truck energy use and air quality impacts.

ITS technologies and architectures: private vs. public sector. The differences in public and private sector application priorities carried over to ITS technologies and telecommunications architectures.

Particularly in long-haul trucking, the mix of goals and available technologies emphasized distributed long-range mobile technologies. Vendors developed on-board computers integrated with satellite-based location determination systems. Satellite-based wide-area telecommunications complemented the location determination capabilities. As cellular phone capabilities and coverage matured, many fleet-oriented ITS tools migrated to dual mode or strictly cellular communications. The computers and communications tools monitored and reported data from on-board sensors for cargo condition, mechanical performance, cargo security, and driver emergencies. All the distributed capabilities were pulled together in centralized fleet management systems, discussed later in this module under Freight ITS and Fleet Telematics. Larger and more innovative carriers built their own systems, while others increasingly purchased off-the-shelf or customized systems.

Other industry segments moved in different directions. For example, ocean carriers providing intermodal container services were among early experimenters with RFID tags for maritime containers, which they referred to as Automatic Equipment Identification (AEI). The innovators selected a particular technology that was developed into an international standard for RFID tags for containers. The International Organization for Standardization (ISO) published the standard in 1991, but no industry or regulatory body mandated actual implementation. Despite the early adoption and later amendments, the standard and RFID technology have had little impact on the container carrier industry.⁹

Major North American railroads followed the container operators' AEI progress. The Association of American Railroads (AAR), the principal industry association, adopted similar technology, but with an important difference. In 1991, the railroads voted to mandate adoption and uniform placement of the AEI tag for rail equipment that moved on more than one railroad, which became common practice. Roughly 1.2 million rail cars and 22,000 locomotives have been tagged.¹⁰

The public sector's ITS CVO technology focus was intermediate-range RFID applications, with transponders (tags) on trucks and readers at fixed locations, such as weigh stations and border crossings. The technology choices followed business

processes and infrastructure.

Not-for-profit regional groupings developed to facilitate operations and limit costs for multi- state carriers (discussed farther in module).

Commercial carriers could choose to participate in a system or not, but the incentives supported participation. Choosing not to participate was generally much more expensive in terms of time lost by drivers in queues.

Moving toward convergence and collaboration. Information and telecommunications technologies continue to improve almost simultaneously in terms of lower costs, greater capabilities, smaller size, and improved reliability. Over the past two decades, many technology constraints eased, and the private vs. public technology clusters blurred, particularly with respect to motor carrier ITS. For example, the public sector-sponsored projects on vehicle-based intelligence (such as drowsy driver detection) and vehicle-to- vehicle interaction (such as automated driving) reflect mobile applications as well as richer infrastructure-to-vehicle capabilities.

Interaction between private and public ITS systems is growing. For example, motor carriers use their vehicle-mounted sensors and computers to monitor and record driver hours-of- service performance information, which must be collected to meet Federal regulations. DOT and other agencies are accepting automated driver log data as definitive, which has resulted in greater confidence in compliance data and less paperwork for drivers.

Introduction to the Research and Technology Sections

As an aid to the reader, below is a synopsis of each of the detailed sections of the module. Each contains a link to the text of the appropriate section. This allows readers to move to areas of interest within the module quickly.

[ITS Technologies for Freight and CVO](#)

This section is a bridge between broad discussions of ITS technologies and architectures in other parts of the *ePrimer* and the particular requirements of freight applications. While the prime objectives of Module 6 involve freight applications, the authors believe readers will learn more from the application discussions when they can place them in the context of technologies and capabilities.

[Freight Management Functions and Requirements](#)

Private shippers, carriers, and consignees drive important freight-related requirements for ITS. This section looks at such requirements from a private sector perspective and explains some of the uses of information technologies in aspects of the domestic and international logistics community.

[CVO, Commercial Vehicle Information Systems and Networks, and Gateway Facilitation](#)

Federal, State, and other governmental bodies are concerned about safe operation of commercial vehicles; efficient, effective administration of credentialing programs; and enforcement of highway weight limits. This section explains Commercial Vehicle

Information

Systems and Networks (CVISN), which is DOT's central ITS CVO program. The section addresses program architecture, Core and Expanded CVISN capabilities, and three successful public-private ITS CVO programs (PrePass, NORPASS, and PierPASS). It also addresses Weigh-in-Motion (WIM) applications and development.

[Homeland and Cargo Security](#)

The September 11, 2001, attacks on the United States heightened awareness among transportation professionals about the need to protect against subversion of commercial transportation systems, threats that might turn productive assets into vectors for attacks. This section addresses the interaction between ITS capabilities, homeland security, and cargo security. The section uses the Intelligent Road/Rail Information Server (IRRIS) and the Defense Transportation Tracking System (DTTS) as illustrative examples.

[Freight Facilitation and Electronic Freight Management](#)

This section describes freight facilitation, including DOT's Electronic Freight Management (EFM) deployment tests and related freight information projects that came from the EFM lessons learned.

[Current Freight ITS Research and the Freight Advanced Traveler Information System](#)

The Freight Advanced Traveler Information System (FRATIS) is DOT's major freight-related ITS research program. This section addresses FRATIS and other current ITS freight research programs.

[Benefits of ITS Freight Applications](#)

The benefits of ITS freight applications are a major theme cutting across the purpose and objectives of Module 6 and the sections. This section pulls together an overview of those benefits, including some private sector improvements and lessons learned about implementing freight ITS improvements.

[Future Directions of ITS Freight Research](#)

This section includes a discussion of future directions of ITS Freight Research, including expected initiatives by the private sector.

ITS Technologies for Freight and CVO

This section sets the technology and communications architecture context for ITS freight and CVO applications. In the authors' experience, many people find it easier to understand freight-related ITS applications after they have an overall sense of the main technology choices and options. The section is also a bridge to other *ePrimer* modules that go more deeply into technologies and architectures, particularly Module 2, "Systems Engineering," and Module 9, "Supporting ITS Technologies."

The first topic is communications architecture, comparing and contrasting long-range, wide- area mobile communications with short-range, fixed infrastructure-to-vehicle communications.

The second topic is core ITS freight technologies. The first subset is asset tracking, which may be applied to vehicles, cargo, critical equipment, and workers. The second subset is on- board status monitoring. The final topic is freight data management. This includes the integration and exchange of freight-related data within and between enterprises. It includes event- and transaction-triggered data and actions, as well as freight performance measures. Data management also includes concerns for data quality (authentication, accuracy, completeness, and timeliness), data security, and privacy.

Communications Architecture

This section addresses the data communications between a truck and the networks that carry or use its data. A truck with wide-area and long-range capability can communicate with its base almost any time and from anywhere; a truck with short-range capability can only communicate when within the (short) range of a transmitter/receiver.

Wide-area mobile communications. This vehicle-centered approach is a hallmark of noteworthy accomplishments by the private sector. Each equipped vehicle has its own communications platform, usually capable of two-way voice and/or data communications. Mobile units capable of long range or over-the-horizon transmission enable true, near real- time event and status-change reporting, regardless of location.

The earliest effective systems for motor carrier fleet use depended upon satellite communications (satcom), which mostly assured geographic coverage without significant gaps in exchange for higher per-character message rates. Satcom remains the method of choice for managing fleets of cargo vessels at sea and for certain safety and security applications. Cellular technology, attractive because of its less-expensive messaging, suffered from gaps in coverage in the 1990s and early 2000s. However, cellular service became more robust and even less expensive as carriers built out their networks. It has become increasingly popular to offer dual- or tri-mode, least-cost-seeking communications alternatives. For example, a mobile system's controller might first seek to use RFID or Wi-Fi communications; if those fail, the controller could default to cellular; and if that fails, the communications controller could default again to satcom.

The relatively higher cost of equipment per vehicle drives the cost profile for wide-area mobile. On-board costs per vehicle have dropped dramatically over the past two decades. However, cost is still meaningful, particularly when multiplied by the number of vehicles (and increasingly, trailers) in large fleets. Per message and per character costs also remain higher than for short-range solutions. Wide-area mobile's inherent cost advantage is clear,

however, when the alternative is populating an extensive geographic network with an infrastructure of fixed readers or read/write communications devices.

The benefits of wide-area mobile solutions include long range, granularity of coverage, timeliness, and flexibility. In the event of a roll-over accident or an attempted hijacking, on-board processors can initiate immediate emergency messages that include location information. Regularly timed reports can feed time and location information to central dispatch systems, which use powerful algorithms to calculate schedule adherence. Upon receipt of a special inquiry or delivery location change, the dispatch systems can contact a driver immediately and adapt the recommended route or schedule virtually in real time.

Short-range infrastructure-focused communications. Public and public-private sector approaches to ITS for freight and cargo operations have typically used fixed infrastructure-oriented telecommunications. Solutions depended generally upon some form of passive or battery-assisted passive RFID tags on vehicles and reader/writers tethered to specific locations, such as a toll gate or a Highway inspection station. Communication distances could vary from several meters to perhaps 100 feet. Individual messages tended to be short and inexpensive. An anonymous commentator neatly described three roles that RFID could fill on a truck: "It could pay tolls, it could handle by-pass on the highway, and also could be used as a modem to dump company data as the truck entered a yard."¹¹

Four programs reflected this short-range orientation. The Commercial Vehicle Information Systems and Networks CVISN grew from concept to become the core of DOT's ITS CVO program; RFID transponders are a critical CVISN component to support information on safety and credentialing. While the CVISN architecture recognizes the proliferation of mobile communication alternatives since 2010, DOT emphasizes the importance of Dedicated

Short-Range Communication (DSRC) for operational safety. DSRC has evolved from vehicle-to-roadside applications to increasingly include vehicle-to-vehicle applications. The third program is DOT's Smart Roadside Initiative, which focuses on truck-related roadside technologies; it is part of the ITS Strategic Research Plan, 2010–2014. The fourth program is the international (particularly, European) counterpart to DSRC: Communications Access for Land Mobiles (CALM). CALM is a program of international standards developed under ISO's Technical Committee (TC) 204, ITS, and CEN, the European Committee for Standardization, TC 278, road transport, and traffic telematics.¹²

The Smart Roadside Initiative was introduced in 2008. Federal Motor Carrier Safety Administration (FMCSA) and FHWA identified four programs and projects to be the primary focus of the prototype development effort. These four programs/projects are:

1. Wireless Roadside Inspections;
2. Universal Truck Identification;
3. Virtual Weigh Station/Electronic Screening; and
4. Truck Parking (Smart-Park)

USDOT initiated a project to develop an overall Smart Roadside concept of operations and prototypes of the applications consistent with the Connected Vehicle program framework. As part of the Smart Roadside prototype development work, system

requirements and
system level architecture have been developed.¹³ Smart-Park research indicates the
need

for ITS applications to truck parking to define commercial vehicle dimensions and detect space availability.¹⁴

ITS applications for general use—for passenger cars—are moving toward vehicle-to-vehicle telecommunications, as discussed in Module 13, “Connected Vehicles.” DOT has an active Vehicle-to-Vehicle (V2V) Truck Safety Program that “aims to accelerate the development and commercialization of commercial vehicle technologies based on V2V and vehicle-to-infrastructure (V2I) wireless communication using DSRC.”¹⁵ As we will discuss in the section on “Future Directions of ITS Freight Research,” the DOT National Highway Traffic Safety Administration (NHTSA) will consider the technical maturity and benefits of V2V in 2013 for light vehicles and in 2014 for heavy vehicles.

The cost profile of short-range infrastructure-oriented communications emphasizes lower costs per vehicle and higher costs on the land side. RFID transponder-based solutions are especially inexpensive per vehicle. The system deployment cost, however, can be much higher when the concept calls for a relatively dense distribution of RFID reader/writers over a network or a series of trade lanes.¹⁶ However, when the operating concept calls for less dense reader/writer networks (such as highway enforcement stations) and large numbers of vehicles, the costs become more manageable. V2V communications cost profiles differ because the on-board technology must be more sophisticated and expensive because of fail-safe anti-crash requirements.

The benefit profile of short-range telecommunications offers highly reliable confirmation of simple transactions, especially identification of a unique vehicle, driver, or load at a particular time and place. Such confirmation can be tied to many database applications, such as tolls, credentials, and enforcement. This is particularly true when the conditions on the ground encourage tight operating discipline (e.g., all vehicles must transit a toll booth); the benefits shrink in the face of unanticipated operating flexibilities (e.g., the ability to bypass a terminal gate).

Core ITS Freight Technologies

The authors consider the three critical technologies for freight ITS to be asset tracking, on-board status monitoring, and data management. This subsection discusses the first two, and the following subsection addresses data management. We also discuss other core technologies.

Asset tracking concerns the whereabouts of freight transportation assets such as trucks, trailers, intermodal containers, chassis, and the cargo associated with such equipment. It includes tools that report if a vehicle or shipment is adhering to a prescribed route. Asset tracking is a critical input into monitoring schedule adherence; it is essential to enhanced carrier fleet management and shipper/consignee supply chain visibility.

Asset tracking is the most important single cluster of technologies for private sector ITS freight applications, and global geographic location determination is the critical foundation piece for asset tracking. The Global Positioning System (GPS) is the best known and most- frequently used wide-area location determination system. Fame has its price, however, and many people conceive of GPS as being much more than it is—as described in the box below.

GPS is Not a Fleet Management
System

GPS is an immensely valuable tool for many ITS and other transportation-related applications. However, it is a contributory tool, not an ITS solution. Many people use the term as a short-hand way to describe robust, wide-area fleet management systems. Careless use of the term *could* lead an ITS professional into a misunderstanding.

GPS is a tool, a network of special-purpose satellites that provides signals used by GPS receivers or transponders to calculate their geographic location. GPS receivers use the signals from multiple satellites to calculate their latitude and longitude to precise degrees. *Other* systems use the location data and may include it in one- or two-way communication systems. GPS itself is not a communication system.

*No motor carrier has a GPS fleet management
system.*

*Most fleet management systems, however, depend heavily on GPS
inputs.*

Fixed signpost RFID solutions are not real-time location trackers, despite occasional advertising claims to the contrary. Such systems can report accurate location information only at the moment when a transponder-equipped asset is within range of the reader/signpost. As time passes (for instance, when an asset is between or away from transponders), the value of the data ages and degrades. The ability to identify current location at will, at any time, and for any reason is significantly more robust and potent.

On-Board Status Monitoring. This is the realm of sensor technologies. Vehicle operating parameters (from road speed to engine RPMs to coolant temperatures to tire pressures and much more) are crucial inputs for carrier maintenance management systems, preventive maintenance programs, and even crash avoidance prior to a developing tire failure or tip- over. Cargo condition sensors for temperature, impact forces, and container pressure have long been used to assure the value and safety of consignments. Security sensors most commonly include intrusion and seal tamper detection (for security against cargo crimes, illegal smuggling, and terrorist threats); another type of security sensor is a “panic button” or emergency call activator for drivers. Driver behavior sensors promise safety improvements from sensors such as drowsiness detection. Some fleet monitoring systems include real- time video and vehicle data monitoring that can capture driving behavior and surrounding traffic, transmit that

information to the carrier's data center, and be viewed later by management or for training purposes.¹⁷ While such systems may raise privacy concerns

among drivers, the systems' appeal is growing among truck manufacturers and DOT safety regulators.

At least three different modes take advantage of on-board monitor data; the choice of modes depends on user priorities, communications capabilities, and cost trade-offs. The choices range from store-and-forward (for downloading and off-line analysis after the end of a shipment) to interactive transmission (especially of safety- and security-related indicators) to instant driver notification.

Intelligent Freight Technologies

DOT published this useful typology of intelligent freight technologies in 2005.¹⁸ It blends underlying technologies and sets of ITS freight applications.

Asset Tracking and *Freight Status Information* primarily concern private sector shippers, carriers, and consignees. *Gateway Facilitation* is mostly the classic cluster of public and public/private sector CVO applications. *On-Board Status Monitoring* historically has been of more concern to the private sector, but heightened safety and security priorities have increased public sector interest in this area. Finally, *Network Status Information* garners interest from public and private sector interests—and from non- freight stakeholders as well. Freight and Network Status Information, as the names imply, both require major database management and display components.



Fonte: *The Freight Technology Story*, 2005, p.12.

Gateway Facilitation technologies tie in very closely with CVO, and we will address those technologies later in this module under CVO, Commercial Vehicle Information Systems and Networks, and Gateway Facilitation.

Freight Status Information and **Network Status Information**, as the names imply, require major data management and access capabilities; they are the focus of the next subsection.

Freight ITS and Fleet Telematics

Increasing numbers of people, particularly in Europe, describe Asset Tracking and On-Board Monitoring together as "Fleet Telematics."

"Fleet telematics refers to the integration of telecommunication and information processing systems to gather and make sense of data relating to fleet activity. ...

[I]nsight generated

help[s] fleet managers to plan and deploy vehicles effectively and manage fleet maintenance and activity to save time and money and offer customers a reliable, high quality service. The systems comprise of two separate parts; the tracking units that are fitted in the vehicles and the vehicle tracking software that creates reports and alerts from the data recorded by the units. ... Fleet telematics systems can be used strategically and tactically to increase fleet efficiency and improve customer satisfaction..."

A relatively new, somewhat promising topic of discussion is "Synergize Insurance with Fleets: Understand fleet operators' key solution requirements such as accurate driving behaviour profiles to align insurance offerings with fleet managers' operations."¹⁹

Freight Data Management

Information about what is moving is often as important as the freight itself. Historically, freight transportation paperwork was notoriously late, incomplete, and inaccurate; an old industry saying was "The cargo moves in spite of the paperwork, not because of it." In the 1960s and

'70s, the railroad and trucking industries pioneered efforts to automate freight information flow. They implemented systems within their companies to help manage the flow of freight data. They also worked with their customers toward automating business transactions including ordering of transportation, billing information, visibility of shipments, and automated payment of bills. The railroads introduced Car Location Messages so that railroad interchange partners as well as shippers and receivers could know the status and whereabouts of shipments. Industry leaders promoted freight data standards such as electronic data interchange (EDI) for domestic and international shipments.

With widespread use of the Internet, carriers began implementing websites that their customers could use to order transportation and to check on the status of shipments. Parcel delivery firms such as United Parcel Service (UPS) and Federal Express (FedEx) became legendary for their automated freight data and their ability to provide an individual customer with precise information about the status of a shipment.

Increasing numbers of railroads, trucking companies, ocean carriers, and firms like UPS and FedEx made great strides at implementing and integrating freight data *within* their companies. Leading large shippers also automated information flows within their companies, but, for a variety of reasons, inter-company integration of freight management data has been more difficult to implement.

Nonetheless, shippers, consignees, and logistics service providers made important and substantial improvements in supply chain data quality and accessibility. "Source data automation" often meant that transactions, such as a terminal gate entry, could generate status messages. Shipment visibility improved with transaction and status data available on carrier websites or, increasingly, computer-to-computer and Internet data links. Delays or unexpected changes in shipment plans could trigger alerts for

supply chain partners. More sophisticated data analytics enabled firms and their partners to better plan shipment routing and scheduling.

The public sector uses freight data for tactical and strategic purposes. Individual shipment information can be critical for CVO safety and regulatory enforcement. Aggregated data, however, is important for State, regional, and Federal project planning and policymaking. FHWA's Freight Analysis Framework (FAF) is a comprehensive array of tools and data on freight network flows. FHWA and other stakeholders have been developing "[f]reight-specific performance measures [that] help to identify needed transportation improvements and monitor their effectiveness. They also serve as indicators of economic health and traffic congestion."²⁰ Examples of freight-specific performance measures include truck travel times on major corridors, dwell or waiting time in a railroad yard or ocean container terminal, average truck speed, or number of hazardous materials released.

The Importance and Evolution of Freight Data

Gough Grubb of retailer Stage Stores said: "The biggest change in 40 years is increased availability of data. We're now at 93% advance ship notice (an electronic packing slip) utilization. With that information, the receiving process is more efficient with scanning of cartons instead of count, sort, and stack...We have a transportation management system that helps optimize loads. When we first installed the system in 2002, we compared calculated routes with those created by people and questioned the automated recommendations. But they looked at the data and found the calculations

were lower in miles and costs."²¹

Freight data is sensitive. Detailed shipment data can reveal sensitive proprietary information. Shippers and consignees consider information about their shipments to be their property; carriers have a similar view about their business between origin-and-destination pairs. Public sector data-related projects pay careful attention to assuring the security and privacy of corporate data. For example, freight performance measures data is aggregated and scrubbed to remove identifying information before use. Industry concerns are barriers to

data sharing with the public sector and often impede the wider adoption of otherwise-successful freight data enhancement projects.²² For example, effective optimization for projects such as Cross-Town Improvement Project (C-TIP) calls for interaction of systems among dray carriers, and some carriers are resistant (see below for more details about C-TIP). Module 12, "Institutional Issues," has further discussion of privacy issues in transportation data.

Freight Management Functions and Requirements

This section discusses the use of information exchange and ITS technologies by private sector companies in the freight and logistics industry. It includes examples of the uses of the technologies in different aspects of freight management.

For the shipper and consignee, the freight movement problem is part of a larger logistics problem: as a business, how can I ensure that I always have the physical things I need

where I need them, when I need them?²³ Physical things may include raw materials, components, and finished goods. In a broader sense, they may include in-process materials, maintenance parts, consumable supplies, tools, and capital equipment. Logistics is the business activity that ensures that physical goods are available in a timely manner, at the required location, and in the required condition to support other functions of the business.

Shippers and consignees are looking for improved levels of transportation service and are very cost conscious. As more than a few carrier executives put it, “Shippers are demanding better service, and they are willing to pay less to get it.” This creates a highly competitive transportation environment.

Integrated Logistics Management

The scope of the logistics function varies greatly among businesses. The box below shows a list of possible functions that a corporation may consider as falling within the scope of business logistics.

Scope of Business Logistics Activities²⁴

- Sales forecasting
- Purchasing
- Inbound transportation
- Intra-company transportation
- Outbound transportation
- Raw material/work-in-progress inventory control
- Finished goods inventory
- Finished goods field warehousing
- Order processing
- Customer service
- Logistics systems planning
- Facilities design
- Materials management
- Logistics administration
- International logistics
- Capital equipment procurement
- Computer processing for distribution applications

Traditionally, logistics professionals focused on transportation, warehousing, and inventory management. More recently, some companies are taking a broader view, but with the same objective, to provide the physical resources necessary to support business activities when and where required. Leading edge companies are integrating these logistics activities to a much higher degree. It may involve integrating information systems for each of these functions to make cross-functional management and coordination possible. Logistics management focuses on all aspects of the supply chain

and means that companies need to

collaborate and often exchange freight data with many diverse partners. Formerly manual processes and documents have been automated. These include electronic bills of lading, acknowledgments of receipt, and even automated bill payment, which can improve the cash flow of all parties to the transaction. It has become increasingly productive to use state-of-the-art communications, information technologies, and data analytics together with core supply chain partners. Some shippers and carriers consider logistics and supply chain management to be core competencies and maintain them internally; others outsource many of the functions and tasks to specialty providers such as third party logistics providers (3PLs).

Just-in-Time Manufacturing

Just-in-time manufacturing reduces inventories by having raw materials and components arrive at a manufacturing site directly from their source at the time required for continuing manufacturing operations. The margin of error in delivery time is typically less than an hour. This approach saves on inventory costs for the manufacturer, but it puts more stress on transportation.

Disruptions from terrorist threats or attacks (such as 9/11) and from natural disasters (such as Hurricanes Katrina or Sandy) had impacts on supply chains and transportation; ultimately, these led to research and processes involving supply chain resiliency and “just-in-case” logistics. Shippers still desire to keep inventories low, but some have decided to maintain enough slack and discipline in the system to adapt quickly and effectively during natural disasters and other transportation system disruptions.

Supply Chain Management

Both shippers and carriers have employed Transportation Management Systems (TMS) to help them make complicated decisions such as modal or intermodal choice, routing, equipment utilization, and carrier selection. Large firms developed TMS as custom systems, and then many moved to server-based systems. These systems continue to evolve, becoming accessible to more and smaller firms via the trend toward cloud-based software-as-a-service (SAAS).

Particularly with the increases in online retail customer ordering and e-commerce, supply chains have become more complex, demanding even greater speed and service reliability. The trend is for smaller, more frequent shipments and a shift toward parcel shipping away from traditional, less-than-truckload (LTL) or larger shipments. TMS systems evolved to support parcel shipping, a departure from earlier truckload (TL) and LTL focus. Globalization of sourcing and assembly required more automated capabilities to handle more complex international shipments. Many shippers coped with higher fuel costs and tighter margins by increasing use of intermodal truck-rail. This resulted in large increases in intermodal volumes, including routine use by major trucking companies. With diesel fuel still in the vicinity of \$4 per gallon in 2013, the trend continues. Another important trend in supply chain management has been the significant complexity in supply chains for e-commerce led by

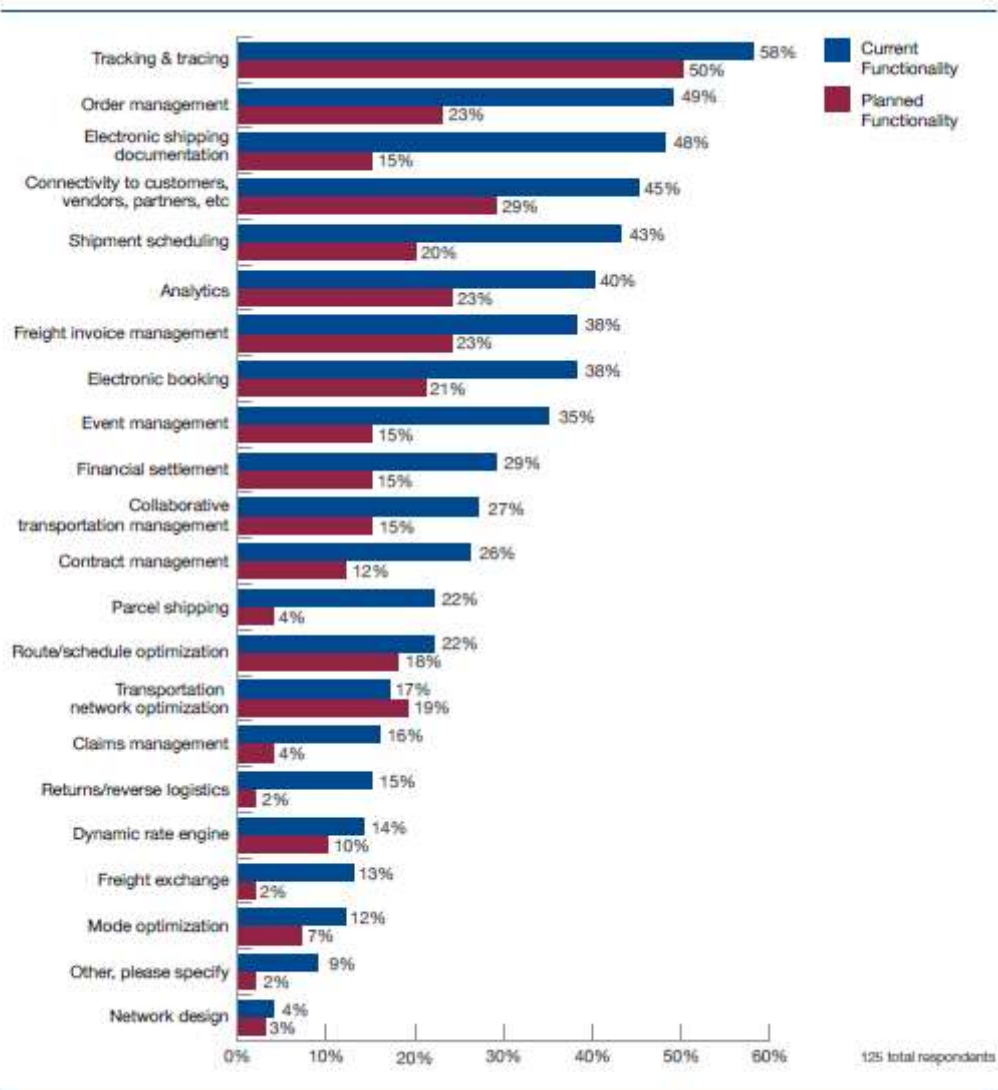
the success of Amazon.com. Their success has also led to more and smaller shipments,

many via the large parcel services such as UPS and FedEx. Sophisticated capabilities used by most large shippers to support global supply chain management by all modes include:²⁵

- multiple language interface screens
- cross-border fees and value added taxes where applicable
- freight settlement and automated invoicing
- interfaces to financial systems
- item visibility to the shipment, pallet, and box level
- performance metrics (e.g. on-time delivery, damage in transit)
- optimization of routes, carriers, rates, and performance

An annual survey of international shippers by *American Shipper* magazine reinforces and amplifies the trends discussed above.²⁶ Figure 1 is an indicator of where shippers' and 3PLs' priorities lie in terms of international TMS functionality. Tracking and tracing is the most significant function, yet more than 40 percent of respondents still say they lack that function, and around half say they want to add or improve on the tracking and tracing capability they already have. Meanwhile, connectivity, freight invoice management, order management, and analytics are clearly future priorities.

Figura 1. Current and Planned ITM Functionality



Source: *International Transportation Management Benchmark Study: Getting More From Less*, American Shipper, 2012.

The *American Shipper* survey found that there is no single delivery model for TMS software capability. There is movement toward more SAAS platforms or cloud-based systems, increasing from 18% in 2009 to 29% in 2012; however, the more traditional models are not nearly obsolete. Customized packages or in-house developments decreased from 30% in 2009 to 24% in 2012.

Some commodity suppliers and retailers, such as food and pharmaceuticals manufacturers, employ technology to trace lots and shipments, which reinforces carriers' needs to track equipment. Some shippers use RFID and shipment tracking and tracing at the lot as well as shipment level. Bar codes and RFID data feeds tie into existing inventory and warehouse systems.²⁷

There are active examples of commercial and public sector web-based freight portals. Carriers and 3PL companies offer websites to their customers for equipment reservations, rates, shipment status, and pick-up information.

In the mid-1990s, the Department of Defense (DOD) began to use active data-rich RFID tags to track ocean-going containers and airfreight pallets. As a large shipper concerned about the visibility of its freight, DOD loaded manifest information onto the data-rich tags. Readers at terminals and gateways throughout the world provided location information.²⁸

Later DOD and Wal-Mart took the lead in requiring vendors to tag shipments with package- and pallet-level passive RFID tags.

With additional data available from supply chain partners and with more powerful computing power, there is a trend toward optimization applications and predictive analytics to further improve supply chain management. Some shippers are experimenting with optimization routines to plan future shipments; some carriers are testing route optimization to improve the utilization of trucks and other assets. For example, Qualcomm and ALK offer this kind of application. Their truck optimization solution calculates optimal truck-specific routes. It provides constant access to on-board highway and street maps combined with PC-Miler commercial truck routing system. Detailed voice instructions use text-to-speech technology.²⁹ TomTom is another in-cab system that provides truck-specific routes for drivers. Widespread use of optimization applications would mean increased efficiencies in freight movements. DOT is funding current research to develop open source optimization algorithms for dray trucks between shippers and ocean or rail terminals. (See the FRATIS discussions below.)

Military Logistics is Important Business

DOD is the largest single customer of commercial freight transportation. The 1990 Gulf War increased demands for data integration and accessibility for commercial containers carrying military equipment. The Gulf War spawned vigorous programs to enhance Intransit Visibility (ITV) and Total Asset Visibility (TAV). The programs attempted to tie together information from DOD's distribution and transportation management systems, including commercial carrier data about events and transactions in the supply chain, updated all the way into the military theater of operations. The Gulf War also spawned experiments and then fielded programs with automatic identification RFID tags to feed data to ITV and TAV. DOD's initiatives and lessons learned were catalysts that accelerated the spread of RFID applications to commercial logistics management.

While there were improvements that helped DOD manage its military actions in Iraq and Afghanistan, their experience has shown how difficult it is to implement ITV in a large and complex organization. According to a Government Accountability Office (GAO) study published in 2013, there are 34 different ITV and TAV efforts in the various components of DOD with no single organization overseeing or directing all of the efforts.³⁰

Carrier Fleet Management

Within a transportation carrier, particularly trucking companies, there are important efforts in managing the transportation assets, whether they are tractors, intermodal containers, container chassis, or truck trailers. ITS technologies and freight management data play key roles in managing carrier assets.³¹

Container, chassis, and trailer utilization. Tractor and truck tracking with mobile communications and location determination is highly advanced and productive in many segments of the trucking industry. In the 1990s, the innovators were the irregular route truckload carriers, which reaped significant benefits per tractor per year as these technologies evolved into industry best practices. As costs drop and successful experience continues to accumulate, usage has been spreading to other industry segments, including LTL and drayage. GPS has played an increasingly important role in maintaining truck location information within urban and regional areas.

Chassis and trailer tracking marries mobile tracking technologies to these dependent conveyances. First generation products faltered around the turn of this century because of technical performance and battery issues, but economics has been the biggest barrier. The CEO of the largest U.S. truckload carrier said in 1999 that he thought “the next revolution” in fleet management would be un-tethered trailer tracking, but the costs were not yet right. By 2004, second-generation products gained more acceptance in the market, with roughly 80,000 units in commercial use.

There were many tests and demonstrations of container security and visibility technologies in the three or four years immediately after the terrorist attacks on September 11, 2001. In the end, most applications were technically immature, economically premature, and failed in the marketplace without government mandates for deployment (see [Post 9/11](#) ITS-Like Technology and Business Initiatives).

From a technical perspective, container tracking is a close cousin of chassis and trailer tracking, but container tracking faces more challenging hurdles. While chassis and trailers are unlikely to leave the United States (let alone North America), the free-flow global nature of the container business makes it much harder to recover the value of an investment in a maritime container tracking device—most investors cannot count on repetitive use of the same container.

The freight transportation industries have long used cargo and freight condition sensors. Perhaps best known, temperature sensors and recorders improve the quality and accountability for perishable shipments. Pressure and toxic substance sensors enhance the safety of hazardous materials (hazmat) shipments. Accelerometers tied with GPS help ensure that rail and highway impacts and shocks stay within contracted limits, help assign responsibility for problems, and help map problem patterns. DOT sponsored operational tests of such technology on U.S. domestic truck and intermodal routes; the equipment included change-of-status detection for tethered or un-tethered chassis.

A DOT-sponsored test in the Pacific Northwest deployed a prototype Web-based border and port terminal screening system, the Trade Corridor Operating Systems (TCOS), which integrated CVISN transponder and e-seal reader network data. TCOS was the focal point that enabled users to cross-reference data and link key information for customs clearance.

Vehicle/power unit location and condition. There are established and growing demands for on-board status information related to freight vehicles and their cargoes. Most solutions simply collect sensor data to transmit en route or store for download at the destination. More robust solutions collect the data, evaluate it, and trigger autonomous actions without prior authorization from central dispatch. An extreme example of the latter, developed in South Africa, is a series of internal pepper gas dispensers to discourage thieves who trigger trailer intrusion detection alarms. A more benign example is automatic restart circuits on refrigerated containers.

Many truckers use tractor-mounted RFID transponders, but more for compliance facilitation and toll payment than for fleet tracking. Some of the Pacific Northwest DOT tests used those applications to monitor the progress of containers drayed along the I-5 corridor between Seattle/Tacoma and the Canadian border. One of those DOT tests used Washington State's port-to-border crossing "TransCorridor" transponder network to track progress as trucks passed under reader antennas at weigh stations, port terminal gates, and border crossings. In the southeast, DOT tested a near-market-ready container chassis tracking system called Cargo*Mate. It packaged GPS, cellular communications, sensors, and a battery within the container chassis frame to improve chassis fleet visibility and management; when the chassis were loaded, Cargo*Mate also improved management of containers and cargo associated with the chassis. An important mid-2000s hazardous materials test involving DOT tested un-tethered trailer tracking, but the focus was less on fleet efficiency than on using the technology to ensure the security and safety of high hazard commodity shipments.

Some truck fleet operators use sensor data on vehicle operating parameters, such as engine revolutions per minute, highway speed, tire pressure, and brake wear. The information helps managers anticipate maintenance problems and reinforce safe and efficient driver behavior.

Driver and vehicle scheduling. Carrier scheduling support is closely related to the transportation Web-based freight portals and congestion alerts and avoidance. Fleet and terminal manager software systems may be programmed to incorporate feeds from regional congestion monitoring portals. At the simple end, dispatchers simply pass along bottleneck information to drivers; more complicated solutions may include dynamic adjustment of trip schedules and strategic shifts in operating policy, such as moving to more nighttime operations. Fleet management software may be useful in accounting for hours of service, time on duty, mandatory rest stops, and similar Federal regulations on

drivers. Software can also be applied to situations where loads travel between terminals and change drivers.

UPS has a cloud-based technology platform that allows shippers to more efficiently collaborate with international suppliers. The system allows more accurate and timely overseas vendor bookings, near real time shipment status, detailed line level visibility of in- transit inventory, facilitation of purchase order consolidation, and optimized shipping plans.³²

All of these capabilities and interactions with customers allow carriers like UPS to better schedule their own vehicles and other assets.

Port and Terminal Congestion Management

The growth in ocean container traffic increases pressure on U.S. seaports, most of which are in urban areas. Congestion costs the carriers, shippers, and consignees money, and port truck congestion spills over onto the highways and surrounding urban areas. Important terminal control systems have been installed at most of the U.S. ports, and several studies of terminal operations have tried to understand the specifics of terminal management and congestion and investigate possible solutions.

One such series of projects was conducted at the ports of Los Angeles and Long Beach over a period of years from 2006 to 2012. The projects captured GPS data from 250 dray trucks at the ports. Port operators and truckers formed a Truck Turn Time Stakeholders Group that oversaw the turn time analysis project. A consulting firm analyzed the data and made recommendations to the stakeholder group. The project looked at queue waiting time to enter the terminal as well as terminal time to pick up or deliver a container at the port. Analysis of 6 months of data showed where bottlenecks occurred. The project was undertaken because trucking and terminal operator stakeholders wanted to improve terminal operations by better understanding and hopefully reducing truck delays.³³ The project developed models to synchronize truck arrivals with port operations. Container stack management strategies, gate appointment systems, and truck queue management used GPS data collected at the ports to realize efficiencies and improvements in terminal velocity.

Real-time location systems (RTLS) are being integrated with yard management systems (YMS) to provide greater visibility, keeping track of every trailer and its inventory.³⁴ The FRATIS project described below is analyzing and working to improve drayage truck movements into terminals while reducing terminal delay times. Several port authorities and private firms (such as e-Modal) mix web access to port-based information (such as ship arrivals) with terminal gate congestion information. Some ports and terminals use appointment systems and others do not, but most have automated the inbound and outbound gate processes in order to improve terminal efficiency and limit the amount of time a trucker has to spend at the terminal. These systems and processes may be more important in the future with hours of service changes so that drivers can get in and out as quickly as possible. The technologies include wireless systems that integrate with active or

passive RFID and GPS. Some software providers are beginning to introduce in-cab software applications that tie in with yard management and provide graphical representation of the yard to help direct the driver to the proper entrance, pick-up or drop-off location, and exit.³⁵

Congestion alerts and avoidance capabilities of many urban ITS applications are useful to many transportation stakeholders and especially important to freight operators in and around crowded gateways, such as ocean terminals and border crossings. Current data from cameras, road sensors, and other sources can be fed into predictive models and distributed via web portals and other means. The Freight Information Real-Time System for Transport (FIRST) was a port-wide system that displayed videos of terminal gates and surrounding roadways for subscribers in the Port of New York/New Jersey. In a DOT-sponsored test, FIRST worked technically and provided useful information, but institutional and competitive issues among some participants precluded active use after the test. Ports in Vancouver, BC, and Virginia's greater Hampton Roads area have operational systems with similar capabilities.

Long queues of idling trucks obviously produce emissions issues. Numbers of public sector environmental agencies work closely with ports and carriers to measure air pollution. Analyses in C-TIP and FRATIS (discussed below), as well as some of the studies in port areas, have computed the expected emissions reductions from technological improvements at the ports and terminals.

CVO, Commercial Vehicle Information Systems and Networks, and Gateway Facilitation

ITS CVO embodies the yin and yang of enforcement and facilitation. CVO programs and related activities, with increasing success, enable accomplishment of seemingly oppositional goals at the intersection of public sector regulations and motor carrier compliance.

Public regulatory interests include safety assurance (safety records, screening, and inspections), special permitting (oversize/overweight (OS/OW)), credentials and tax administration (hazmat, licensing, and much more), and driver authentication (commercial driver's license (CDL) and biometrics). Public business interests include effective use of scarce inspection resources, efficient toll and credential processing, and quick, reliable exchange of information with other jurisdictions and carriers. Carrier business interests include minimizing burdens of regulatory compliance, reducing potential bottlenecks and lost productive time at inspection stations, reducing those impacts relative to certain competitors,³⁶ and optimizing safety performance, insurance costs, and customer satisfaction.

Effective implementation of [gateway facilitation technologies](#) is the foundation of successful CVO programs. Such programs enable the simultaneous accomplishment of public and private interests. Many benefits have already been delivered and, in the spirit of continuous improvement, more are on the way.

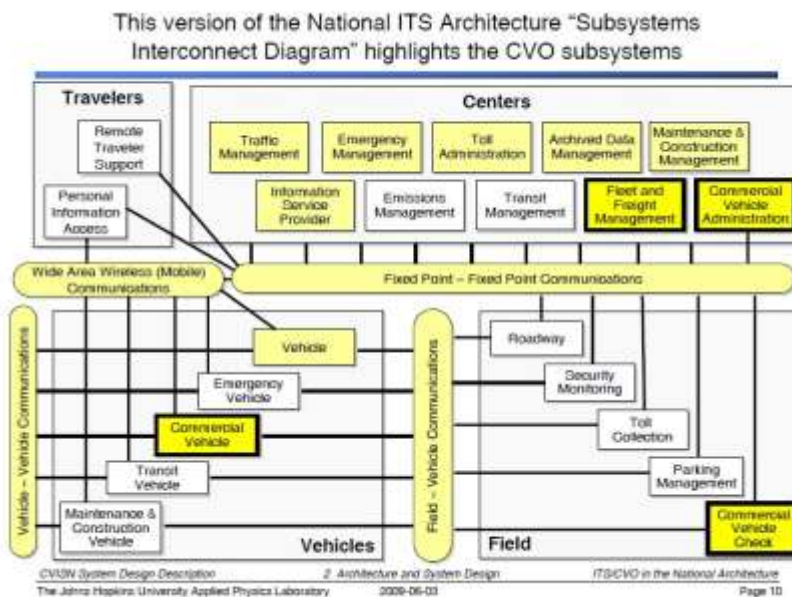
The CVISN program is the core of ITS CVO. The first subsection explains the CVISN architecture and how it fits into the National ITS Architecture. The second subsection

addresses the core and expanded capabilities. The final subsection reports on examples of CVISN and CVO deployment.

CVISN Architecture

CVISN is DOT's central CVO program, and Figure 2 highlights the CVO subsystems in an overview of the National ITS Architecture. (The figure is from a clear and easy-to-use CVISN [report](#) on FMCSA's website.³⁷) The diagram is here to give readers a sense of CVISN's breadth, diversity, and complexity.

Figure 2. CVO Subsystems in the National ITS Architecture³⁸



The Commercial Vehicle Administration "Center" represents the public and regional agencies that administer CVO activities and exchange information with each other, as in credentialing. These Centers usually communicate with Field Activities that perform inspections and provide other services. Field Activities communicate with commercial vehicles via RFID transponders mounted on the vehicles, which interact with roadside readers. (This is an application of [DSRC](#).) The vehicle-roadside links facilitate roadside check and inspection operations.

The diagram helps illustrate some of the differences and interfaces between private sector and public-private ITS applications. The architecture includes Fleet and Freight Management Centers, but such Centers are parts of private firms, not creatures of the public

ITS program. In the architecture, these Centers interface with public CVO applications related to credentials, taxes, and drivers. However, carrier executives would point out that the Centers' primary purpose is to support carrier business: they provide dispatch operations, cargo tracking, customer interfaces, hazmat management, fleet maintenance management, security, and other functions.³⁹ The interfaces with ITS

CVO functions, while

important and valuable, are ancillary to the core purpose of transporting cargo for customers.

CVISN's Commercial Vehicle Subsystem—the on-board equipment—includes capabilities that serve both the CVO program and the operator's business interests:

- CV Electronic Data (supporting communication of IDs and other messages)
- Trip Monitoring (for asset tracking and fuel reporting)
- Cargo Monitoring (monitoring cargo condition)
- CV Safety and Security (collecting and sharing safety and security information)
- Driver Authentication (for identifying driver changes)

Electronic tools to manage and track most of these on-board capabilities are optional for carriers; in most cases, the business argument for installation strongly favors adoption, but that is qualitatively different from a regulatory mandate.

CVISN Capabilities

The CVISN Program defines two levels of capabilities, Core and Expanded. Core CVISN includes compatibility with CVISN principles and standards, basic capabilities for information exchange, credentials administration, electronic screening, and expandability. Expanded CVISN is an almost open-ended menu of additional applications and more extensive deployments: the program offers suggested examples, not limits. This subsection explains the Core and Expanded programs and illustrates a central component technology: Weigh-in- Motion (WIM).

Core CVISN capabilities rest on three foundational elements: an organizational framework

for cooperative system development between a State's public agencies and motor carriers; a State CVISN System Design that can evolve to include new technical capabilities; and implementation of three specific functional capabilities. The system design and functional capabilities must use applicable standards and guidelines in accordance with FMCSA's CVISN program.⁴⁰

In a broad sense, Core CVISN capabilities include:

“Electronically collecting and exchanging safety performance and credentials information within the State and among States, Federal agencies, and motor carriers;

“Deploying transponder technology to identify and electronically screen commercial vehicles at mainline speeds; and

“Using websites or computer-to-computer exchange for motor carrier companies to apply for, review and pay registration fees and returns on fuel taxes with State agencies and for States to participate in the International Registration Plan (IRP)

and International Fuel Tax Agreement (IFTA) clearinghouses.”⁴¹

These broad statements translate into three specific capabilities to be “checked off”:

1. *Safety Information Exchange*. All major inspection sites in each State use standard formats to report data directly or indirectly to FMCSA’s Safety and Fitness Electronic Records (SAFER) system. CVO Administration Centers in the State connect to SAFER. Agencies have deployed the Commercial Vehicle Information Exchange Window (CVIEW) or an equivalent capability. CVIEW enables exchange of data among State agencies and, together with SAFER, with other states.
2. *Credentials Administration*. CVO Administration Centers and carriers can exchange and process information automatically via Internet or computer-to-computer links. Core CVISN “includes carrier applications, State application processing, credential issuance, and tax filing” for at least the IRP and the IFTA. CVO Administration Centers must be *capable* of including other credentials, but not necessarily have implemented other credentials capabilities. In all cases, automated processing includes posting updates and changes to SAFER for immediate interstate accessibility.
3. *Electronic Screening*. In Core CVISN at least one fixed or mobile inspection site is able to use SAFER/CVIEW and other data snapshots to support screening decisions, and the State’s agencies are ready to replicate the capability at other inspection sites.⁴²

Readers interested in a graphic illustration of SAFER/CVIEW exchange of electronic data can find it [here](#), on page 39.

Expanded CVISN. Expanded CVISN is a flexible range of possibilities, not a prescribed slate of capabilities. As long as implementations remain compliant with CVISN’s standards and architecture, jurisdictions may expand beyond Core deployments according to their own priorities.

FMCSA’s Five Examples of Expanded CVISN Projects⁴³

Virtual Weigh Stations

A virtual weigh station is a roadside enforcement facility that does not require continuous staffing and is monitored from another location. Virtual weigh stations are established for a variety of purposes depending on the priorities and needs of each jurisdiction. Typical purposes include safety enforcement, data collection, security (e.g., homeland security, theft deterrence), and size and weight enforcement. These sites may use a variety of sensor components to collect data, such as a WIM installation, a camera system, and wireless communications.

License Plate Readers

License Plate Recognition (LPR) is an image-processing technology used to identify vehicles by their license plates. Some states have implemented this technology to augment e-

screening capabilities.

Oversize/Overweight Permitting

While IRP and IFTA e-credentialing were requirements of Core CVISN, electronic support for permitting has been an interest of both industry and State personnel. Oversize/overweight (OS/OW) loads are special case shipments that exceed the operational parameters defined by the State. The correct routing of these shipments makes sure that mobility, safety, and security concerns are addressed. A number of states are actively involved in projects involving OS/OW electronic permitting and route planning, and some are incorporating bridge analysis into their OS/OW systems.

One-Stop Shops and Electronic Portals

A Web portal or one-stop shop can provide a way for a State to give a consistent look and feel across multiple applications for back-office users, enforcement, and motor carriers. A State may provide an electronic one-stop shop through which motor carriers can access the State's IRP, IFTA, and OS/OW permitting systems. Such a portal may provide single sign-on access to all users, which would allow a user to log in to the portal using a username and password and then be directed to specific credentialing applications without having to log in again.

Driver Information Sharing

Given that high-risk drivers are involved in a disproportionate number of crashes, the driver information sharing area of Expanded CVISN is likely to have a large impact on safety. A State's CVIEW could be enhanced to include driver information, improving an enforcement officer's ability to check driver credentials for safety problems. Card-swiping devices and biometrics may be included in the system for linking the driver in the vehicle to his or her CDL.

Weigh-in-Motion. State inspection stations pay particular attention to screening overweight trucks and enforcing gross vehicle weight and axle weight requirements. Vehicles carrying too much weight are safety risks via crashes and breakdowns that obstruct traffic. In addition, excess weight has an exponential impact on roadways, significantly accelerating deterioration. Highways represent significant public investments, and reasonable weight restrictions protect the life of those investments. Finally, abuse of weight limits gives a successful evader a business advantage over compliant competitors—evaders deliver more cargo with fewer trips and fewer driver hours. Weight limit enforcement rewards compliant carriers by keeping the playing field level, and the enforcement also serves as a deterrent for carriers subject to temptation. WIM, described in the box below, is a potent tool to increase the efficiency and effectiveness of weight limit enforcement.

Weigh-in-Motion
The "Holy Grail" for Weight Limit
Enforcement

Readers “of a certain age” are more likely to recall driving by or through fixed highway weigh stations. For a long time, static scales, high in accuracy and relatively low in cost, were the primary means of inspecting for and detecting overweight vehicles. Static scales are well-suited to low traffic volumes but much less effective as truck volumes increase. If enforcement officials try to inspect many trucks in

a limited time, one of two things is likely to happen: significant congestion, delays, and many unhappy stakeholders, or “waving through” most trucks without a check; neither outcome yields effective or efficient enforcement.

WIM technologies are not new. In existence for “well over 50 years,” their primary application in the United States has been collecting data for highway engineering and planning. As recently as 2011, most of the roughly 800 U.S. WIM installations were used for that purpose.⁴⁴

Oregon, a leader in WIM enforcement applications, began to experiment with it in the 1980s and included WIM in its “Greenlight” program at its inception in 1995. By 2007, Oregon had automated its 22 busiest weigh stations and enrolled more than 40,000 trucks in the program.⁴⁵

Weighing trucks at highway speeds extends the benefits of electronic screening and bypass from credentials and safety records to actual weights. Highway-speed sensors can triage the flow of truck traffic, separating high-confidence compliant vehicles, high-confidence noncompliant vehicles, and borderline cases. Depending on volumes, at a minimum, trucks highly likely to be in violation can be diverted to static scales for precise measurement and enforcement actions.

The “Holy Grail” for overload enforcement is “a technology that enables fully automatic and direct WIM enforcement”—meaning sufficiently accurate to support prosecutions and sharply reduce the need for triage to static scales. In the spring of 2012, a respected expert commented that such a sensor might reach the market in about 18 months.⁴⁶

Another area of development is virtual weigh stations (VWIM) for deployment on less-heavily traveled highways. VWIM is a WIM system coupled with cameras, perhaps license plate readers, and a web interface “to monitor the passage of vehicles in real time.”⁴⁷

Several YouTube videos may be interesting:

- For an animation illustrating the WIM concept in action, click [here](#).
- For a driver’s perspective on and experience of a WIM inspection, click [here](#).
- For a law enforcement perspective and WIM technology approaches, click [here](#).

CVISN Deployment Successes

There are numerous examples of successful CVISN deployments. This subsection describes PrePass, NORPASS, and PierPASS. PrePass and NORPASS are classic CVISN systems focused on State regulatory programs; PierPASS is a non-governmental initiative to mitigate congestion in the vicinity of marine terminal gates.

PrePass

PrePass is the continent’s largest ITS CVO consortium, addressing safety, credentials, and vehicle weight. PrePass includes 301 inspection and weigh station bypass sites in 31 states and aspires to extend its reach. An interactive map enables website visitors to view PrePass states and drill down on weigh stations, activity, and benefits in several ways ([PrePass](#)).⁴⁸

The concept that evolved into HELP PrePass is about 30 years old, dating to 1983. The

Heavy Vehicle Electronic License Plate (HELP), then the foremost ITS CVO program,

culminated in a successful DOT-funded demonstration called the Crescent Project. In 1991, Crescent included six states and one Canadian province in an arc from the Pacific Northwest to Texas.

Absent Federal funding at Crescent's conclusion, HELP participants created a public-private partnership to fund and support operational deployment of PrePass capabilities. Today HELP, Inc., is a not-for-profit corporation; its governing board is divided equally among State and industry representatives.

The culmination of HELP, Inc.'s efforts is PrePass—an intelligent transportation system that electronically verifies safety, credentials, and weight of commercial vehicles at participating State highway weigh stations, commercial vehicle inspection facilities, and ports of entry. Installation of the basic PrePass equipment at many State inspection facilities is funded by HELP, Inc., and provided to states without the use of public funds. Motor carriers who voluntarily participate fund the system with monthly service charges.⁴⁹

RFID transponders, similar to toll tags, trigger the PrePass bypass process; each transponder uniquely identifies the truck and ties to databases with information about the truck, load, and driver. The PrePass website includes a helpful illustration of a typical [bypass scenario](#) and an interactive carrier [Benefit Calculator](#).⁵⁰

PrePass began operating in 1997, and HELP, Inc., has measured and estimated annual benefits for states, carriers, and the environment. These are discussed under [CVISN Benefits](#).

Looking ahead, PrePass offers four new applications:⁵¹

1. *PrePass Plus* rolls together the PrePass CVO tag and the E-ZPass toll collection tag. The single tag and back-office support simplify carrier accounting and transponder management.
2. *PrePass Gates* adds an access control application built on the RFID transponder. Carriers may equip terminal and parking area gates with electronic readers to facilitate arrivals, departures, and record-keeping.
3. *PrePass Ag* is offered by Florida's Department of Agriculture and Consumer Services. It brings the concept and processes of PrePass to agricultural interdiction stations, enabling qualified carriers to avoid agricultural inspection stops.
4. *PrePass eLogs* offers fleet operators a service that scans driver logs, does a standard audit, and offers optional daily fuel audits. eLogs flags and tracks risky drivers and supports enforcement actions with notification letter capabilities. eLogs is not an official regulatory audit, but the brochure asserts that, "Every customer using PrePass eLogs that has been audited by the DOT has received a 'Satisfactory' rating!"⁵²

NORPASS

The North American Preclearance and Safety System (NORPASS) is the continent's second-largest ITS CVO consortium. Seven U.S. states and two Canadian provinces are affiliated with NORPASS (six as members and three as partners). As the coverage map shows, there is a solid band from Idaho through Oregon, Washington, and British Columbia to Alaska. The other members are South Dakota, New York, Connecticut, and Quebec.⁵³ (Kentucky and North Carolina have left NORPASS; Kentucky joined PrePass, and North Carolina established stand-alone NCPass.)

NORPASS functions similarly to PrePass, enabling automated bypasses related to safety, credentials, and vehicle weight. An RFID transponder is again the unique identifier for a truck, and it is the key to State, provincial, and other databases. The transponder is compatible with the toll tags used in the 14 State BESTPASS system and with the PrePass transponder.

Unlike PrePass, NORPASS truckers pay no user fees—states and provinces cover the operating costs, which may explain some of the shrinkage in NORPASS member states. Truckers are required only to register a compatible transponder and maintain updated IRP registration information at NORPASS.

NORPASS tracks benefits to users but presents the information as a “live” web counter showing bypasses and savings (USD) since January 2010 (9.3 million bypasses and \$80.8 million as of February 7, 2013). The dollar savings reflect a 2007 FMCSA study that estimated that each bypass saves \$8.68.⁵⁴

PierPASS

PierPASS is a not-for profit organization created by the Marine Terminal Operators (MTO) in the ports of Los Angeles and Long Beach (LA/LB). A multi-purpose, industry-initiated CVO program, it addresses port operating efficiencies, road and highway congestion, air quality, and port security concerns. PierPASS began operating in 2007.

LA/LB are the nation's highest volume intermodal container ports. Metropolitan Los Angeles is infamous for traffic congestion and air quality issues. In 2011, about 140,000 trucks visited LA/LB's marine terminals each week.⁵⁵ The visible presence of so many containers amid heavy traffic was impossible to miss, and it added a public relations component to the business, as well as civic pressures on the MTOs and the truckers to mitigate the ports' contributions to congestion. When some people grumbled that LA/LB suffered congestion costs in order to provide goods and benefits to other parts of the country, it did not help the industry's public relations issues.

Motor carriers are no fans of port congestion. The 140,000 weekly truck visits to LA/LB's ports were more dray than long haul operators. Drayage carriers usually work within a fifty mile radius of the port, and drivers are paid on the number of turns (completed trips) to and

from the terminals. Heavy congestion and long terminal wait times mean dray drivers and owners earn less money.

Longshore labor unions limited operating flexibility; prior to PierPASS, most marine terminals kept close to normal business hours—with limited night or weekend service to receive loaded or empty containers. MTOs initiated appointment programs to reduce crowding at terminal gates, but with limited success.

PierPASS was a creative business solution for congestion mitigation, not a technology innovation. To relieve LA/LB's port congestion, MTOs opened for some night and weekend shifts: every international container terminal in LA/LB began operating five off-peak shifts per week, usually Monday through Thursday nights from 6 p.m. to 3 a.m., and Saturday from 8 a.m. to 5 p.m. To encourage truckers and shippers to use the off-peak hours and to cover costs, PierPASS charges a Traffic Mitigation Fee (TMF) for terminal access during peak hours, 3 a.m. to 6 p.m., Monday to Friday. Since mid-summer 2012, the TMF is \$61.50 for a 20-foot container and \$123 per 40-foot container.⁵⁶ Off-peak PierPASS is an improvement, not a perfect solution. For example, one driver complained online that if he arrived after 6 p.m. Friday, he had to wait 12 hours until the terminal opened. In another example, an MTO told FRATIS project analysts that trucks queue up in a parking area for several hours in the afternoon waiting for the 6 PM off-peak hour. Such trip planning and built-in delay makes overall container economics more difficult to diagnose.⁵⁷

PierPASS includes an RFID "TruckTag" to enhance port security and facilitate terminal gate operations for the terminal and the trucker. A TruckTag, similar to an E-ZPass toll tag, is attached to a tractor's rearview mirror. To be eligible, trucks must already be accepted in a "Truck Check" program run on behalf of LA/LB by eModal. The tag is read at the marine terminal gate to verify the truck and driver's security clearance to enter the terminal. The unique tag ID links to database information about the load, the truck, and the driver. The truck's status is checked in the Drayage Truck Registry (DTR), and the driver, identified by CDL, must be authorized by her or his employer to enter the port facility.⁵⁸ The TruckTag enables MTOs to automate the gate check-in process.

Homeland and Cargo Security

This section addresses three topics, two of which are ripples caused by 9/11. The first subsection looks at the security process and freight data impacts of the terrorist attacks. The second subsection touches briefly on the large bloom of publicly and privately funded freight-related technology solutions floated, tested, demonstrated, and applied—with little business success—in the years following 2001. The final subsection describes several asset tracking, on-board monitoring, and analytic systems developed by or on behalf of the Departments of Defense and Energy.

Process and Data Impacts of 9/11

The aftermath of the terrorist events of September 11, 2001, brought significant changes to global supply chain management, especially in supply chain security and in the freight data exchanged between trading partners and customs agencies. This subsection addresses ITS-related security and freight data changes.

Traditionally, cargo security concerned theft, pilferage, and smuggling; smuggling included drugs and other forbidden material, people, “graymarket” goods, and items subject to high customs duties. Al Qaeda’s conversion of commercial airliners into weapons reshaped the landscape, as stakeholders saw freight containers in particular as potential weapon delivery devices. Emphasis increased significantly on knowing what was in international marine and air containers and cross-border trucks and railcars—that is, demand increased for accurate cargo documentation. Emphasis also increased significantly on securing containers, trailers, and railcars with processes and devices that retarded unauthorized entry and significantly reduced the likelihood of undetected tampering.

Private companies and governments around the world invested in systems to improve supply chain security. There has been no major supply-chain related terrorist attack, which is a credit to industry and government security officials, but the threats remain. Given the vast scope and complexity of global trade, the best that can be done is to reduce the odds and probabilities of successful terrorist penetration. “The only way to *guarantee* a completely secure supply chain is not to ship any freight.”⁵⁹

After 9/11, in 2002, the United States government led international efforts to secure the supply chain when U.S. Customs and Border Protection (CBP) introduced three programs. The Customs-Trade Partnership Against Terrorism (C-TPAT), originally a voluntary program, promotes adoption of security best practices among shippers, carriers, consignees, and their supply chain partners; CBP reviews corporate security plans and periodically “validates” (inspects) compliance.

The Container Security Initiative (CSI) “pushed out the borders” with prescreening of U.S.- bound container cargoes at selected originating ports; CSI also initiated the use of ITS-like technologies to automate container and cargo screening with x-rays, gamma rays, and other solutions. Container screening is now conducted both in participating foreign ports and upon arrival in the United States, in part with scanners provided by DHS to the foreign customs agencies. In addition, all air cargo entering the United States is scanned.

CBP’s third initiative, the 24-Hour Advance Manifest Rule, directly affected supply chain data flows. The 24-Hour Rule required electronic delivery to CBP of container cargo manifest and related information at least 24 hours before a container could be loaded aboard a U.S.- bound vessel. The delay provided CBP with a window to analyze the information (to look for suspicious patterns) and deny boarding for containers that merited closer inspection; this approach meant an entire shipload of containers would not be delayed to offload one

suspect container. (CBP developed its screening system, the classified Automated Targeting

System (ATS), in the 1990s and enhanced it significantly after 2001.) In 2009, CBP augmented the 24-Hour Rule with the more stringent Importer Security Filing, commonly known as "10+2." The current rule requires importers to provide 10 essential data elements about a container, and carriers must provide two items (the vessel stow plan and container status messages). Importers must deliver their information at least 24 hours before container loading, and carriers must deliver their information 48 hours after vessel departure for the United States.

The 24-Hour Rule and 10+2 were near-revolutionary, not because of new data elements but because of the urgency about deadlines: unless supply chain data were accurate, timely, and complete, practical penalties could be severe. Third-party logistics providers and others developed or enhanced 10+2 software packages or services.

Importer Security Filing Data Elements
(10+2)

- The "10" data elements that must be submitted 24 hours before a container is loaded on a U.S.-bound vessel are:
 - 1) Manufacturer (or supplier) name and address
 - 2) Seller (or owner) name and address
 - 3) Buyer (or owner) name and address
 - 4) Ship-to name and address
 - 5) Container stuffing location
 - 6) Consolidation (container stuffer) name and address
 - 7) Importer of record number/ foreign trade zone applicant ID number
 - 8) Consignee number(s)
 - 9) Country of origin
 - 10) Harmonized Tariff Schedule number (HTSUS)
- The "+2" data elements are data files that an ocean carrier must transmit to the CBP within 48 hours of a vessel's departure. These elements are:
 - 1) Vessel Stow Plan to indicate the location of each container on the ocean vessel
 - 2) Container status messages (CSM), which detail information on the movement and status changes of a container as it travels through certain parts of the supply chain; these must be submitted to CBP within 24 hours of being received in the carrier's own system

Fonte: *ANSI X-12 309 U.S. CBP Importer Security Filing (ISF-10 and ISF-5)* specifications for ASF data elements, May 16, 2011, and *Importer Security Filing ISF 10+2 Guide*, www.logisticswisdom.com.

Security requirements also increased at land borders. Non-Intrusive Inspection (NII) scanners, such as SAIC's Vehicle and Cargo Inspection System (VACIS), screen all trucks

entering the United States. Driver identification requirements are tighter. Especially in the immediate aftermath of 9/11, legendary delays at most border crossings spurred governments, shippers, carriers, and other stakeholders to identify and implement processes and technologies to help relieve congestion while improving security. For example, ITS Advanced Traveler Information Systems (ATIS) solutions provided advanced information about border delay times so that travelers and truckers could adjust their travel plans.⁶⁰ Enhanced cameras and digital license plate readers improved the accuracy and speed of vehicle processing.

The TSA, after a difficult development and implementation process, launched the biometric Transportation Worker Identity Card (TWIC) in late 2007. Workers who require unescorted access to marine facilities and vessels must have a TWIC, including merchant mariners, port terminal workers, longshoremen, and some truck drivers. TSA and the Coast Guard enforce the TWIC requirement. Cumulatively through mid-January 2013, 2.4 million applicants received cards, and 2,500 people received final disqualification letters.⁶¹ The TWIC concept is a classic Freight ITS enhancement, and it would fit in other freight transportation environments. However, given the program's difficult birth, no other freight segments seem to be rushing to further deployment.

Post 9/11 ITS-Like Technology and Business Initiatives

In addition to cargo security and supply chain data initiatives, 9/11 spawned a host of government- and privately-sponsored technology initiatives to enhance cargo and freight transportation security and to improve supply chain visibility and management. There were far too many examples to address in the limits of this module, especially since ultimate commercial success and adoption was rare: absent government mandates for deployment at private expense, the privately-funded business initiatives shriveled and closed. As an illustration of the volume of initiatives, a 2004 report identified more than 40 secure trade-oriented technology projects underway and in advanced planning.⁶²

Some technology initiatives focused on pure security enhancements that would have imposed costs on supply chains; others focused on “have your cake *and* eat it too” doubly productive solutions. In general, the second group included security improvements that helped improve supply chain business practices and visibility enhancements that would generate better security as a “collateral benefit.”

Operation Safe Commerce (OSC) was the largest single initiative, managed by TSA, initiated in 2002, and run through several cycles of multiple contracts awards and grants. The OSC vision was “a program to fund business initiatives designed to enhance security for container cargo moving internationally. OSC will provide a test bed for new security techniques that have the potential to increase the security of container shipments.”

OSC and similar initiatives, including direct research funding from CBP, fostered demonstrations of “smart box” solutions including Container Security Devices (CSDs)

and electronic cargo seals (eSeals). Most of these on-board devices did not achieve levels of reliability (especially the absence of false positives) that would satisfy carrier personnel and their supporters.

Smart container and smart trailer technologies hold great potential to deliver benefits to shippers, carriers, regulators, and other stakeholders. The projects in the aftermath of 9/11 had the right ambitions but were ahead of their time.

Defense Transportation Tracking System, Transportation Tracking and Communications System, and Intelligent Road/Rail Information Server

Two government agencies developed and operate systems to track sensitive government shipments. One is the DOD's Defense Transportation Tracking System (DTTS), and the other is the Department of Energy's (DOE) Transportation Tracking and Communications System (TRANSCOM). DTTS monitors shipments of arms, ammunition, and explosives (AA&E), and the TRANSCOM System monitors shipments of radioactive waste.⁶³ Route adherence monitoring is a special application of asset tracking. "Geo-fencing," as it is often called, uses algorithms to analyze and display location data, enabling commercial dispatchers and (conceivably) law enforcement officials to quickly identify and address exceptions such as route deviations, restricted area entries, and emerging schedule failures. Geo-fencing can work with any mobile communications-based tracking of tractors, trailers, and chassis. A DOT-sponsored hazmat shipment test in 2004 assessed geo-fencing and concluded that both DOD's DTTS and DOE's TRANSCOM system use it successfully.⁶⁴

The Department of the Navy developed DTTS in 1986 following an incident when Navy torpedoes rolled out of a commercial motor carrier onto Interstate 25 within Denver, CO. DTTS, later expanded to cover all of DOD's commercial shipments of AA&E in the continental United States (CONUS), monitored shipments and initiated emergency response to any in-transit accident or incident. Relatório da Controladoria Geral da União dos EUA Transportation Command (USTRANSCOM) manages DTTS today.

IRRIS, the Intelligent Road/Rail Information Server, is another DOD-developed system that includes asset tracking. It is a Web-based geospatial transportation information intelligent server begun in 1999 for the Transportation Engineering Agency (TEA), part of USTRANSCOM's Military Surface Deployment and Distribution Command (SDDC). TEA designed IRRIS to support analysis of CONUS infrastructure readiness. IRRIS now provides worldwide infrastructure and near real-time data for decision makers. IRRIS taps multiple data sources (including an hourly feed from DTTS) and integrates the data to provide information in support of a broad range of transportation information requirements.⁶⁵

IRRIS incorporates geographic information systems (GIS) and location-based services into a common interface, providing a single point of access for real-time command and control. IRRIS technology integrates a variety of static and real-time information,

including road

conditions, construction, incidents, and weather, and displays data through an interactive mapping interface.

The SDDC and its contractor, GeoDecisions, developed IRRIS as an open system, so it can incorporate information from a variety of sources. For example, while IRRIS does not directly receive satellite asset tracking feeds, it accepts them from DTTS. IRRIS also serves other Federal and State agencies and some private sector users.

IRRIS uses turn-by-turn, address-to-address, or latitude/longitude driving directions with total drive time, mileage, and maps to guide and monitor the various transportation types and to create a route on a map that includes barriers (e.g., flooding; bridge and road closures), enhancing response strategies and execution. GeoDecisions also offers Web services that provide mapping and vehicle route calculation capabilities, allowing the system to support varying user needs across multiple industries. The IRRIS website, maintained by its developer, is a flexible, interactive tool that demonstrates its range of capabilities:

www.iris.com/capabilities.htm.

Freight Facilitation and Electronic Freight Management

This section discusses industry and international standards for data exchange, as well as DOT projects that used or built upon and then expanded data sharing among private sector firms to improve freight efficiency.

Electronic Data Interchange

One of the backbones of eCommerce is Electronic Data Interchange (EDI), a standard method of exchanging files that was developed in the 1980s.⁶⁶ Put simply, EDI is the process of transferring standard business documents between trading partners. These could be wholesale or retail business entities that supply or sell products. EDI involves using electronic methods to place an order or receive order-related information, such as ship notices and invoices. EDI came about so that different trading partners with different computer systems could exchange and then convert data without having to manually re-key data. Over the years, EDI became widely adopted throughout the retail, manufacturing, and transportation industries for exchanging data between entities.

Over time and with advances in computer and communications technologies, EDI has evolved. Some of the changes have included the introduction of EDI translation software and Value Added Networks (VAN) and companies that act as bridges between trading partners to pass transactions. Such EDI providers are responsible for data translation mapping to ensure that data flows accurately between trading partners. Now, with the Internet, EDI providers can store the maps of all the possible transaction sets and trading partners. In addition, file transfer protocol (FTP) over the Internet has become more widely used and can save users data exchange costs compared with VANs.⁶⁷ What used to be a very expensive proposition for small companies is now

much more attainable by taking advantage of some of today's technological advancements. Internet-based standards have

also been introduced, including eXtensible Mark-Up Language (XML) and Uniform Business Language (UBL) data standards, but with the same principles of allowing data to be transferred electronically between unlike systems and operations.

Among the most common EDI transactions for general business and transportation are:

- Transportation Carrier Shipment Status Message (EDI 214)
- Invoice (EDI 810)
- Payment or Order Remittance Advice (EDI 820)
- Purchase Order (EDI 850)
- Advance Shipping Notice (ASN) (EDI 856)

Each of these documents has a standard format developed and maintained by the American National Standards Institute (ANSI) known as the Accredited Standards Committee (ASC) X12. The X12 Committee develops and maintains EDI standards along with XML schemas that are used in global business processes. In practice, however, each trading partner may deviate slightly from the standard, making it necessary to have intermediaries to map the data accurately from one entity to the other. Evolution to the Internet has included EDI-INT, a set of standards for transferring EDI files through the Internet more securely.

The exchange of EDI data involves three major processes: mapping, translation, and communications.

- Mapping involves transforming an EDI document into another format (such as XML, a flat file, a delimited file, etc.) or vice versa. Mapping is essential for proper system integration at each end of the transaction, and it helps avoid re-keying of data.
- Translation is the process of accepting inbound EDI data, or preparing an outbound file for transmission. Each trading partner translates the appropriate data into EDI and then translates the incoming data into its back office systems.
- Communications refers to the transmission of the EDI transaction. This can be done indirectly (through an external clearinghouse or VAN) or directly (using EDI software, a Web-based EDI tool, or outsourcing with an EDI service provider).

Electronic Freight Management

To address the freight data quality problem and advance the quality and availability of connectivity, collaboration, and the creation and use of actionable intelligence, DOT worked closely with the freight industry to address data-related problems inherent in complex supply chains; they worked together to develop the Electronic Freight Management (EFM) Initiative.⁶⁸ The EFM Initiative project applied Web technologies that improved data and message transmissions between supply chain partners. It promoted and evaluated innovative e-business concepts, enabling process coordination and information sharing for supply chain freight partners through public-private collaboration.

Collaboration took place beginning in the late 1990s in the Intermodal Freight Technology Working Group (IFTWG), operating as a committee within the Intermodal Association of North America (IANA). Starting in 2004, the EFM Initiative's goal was to advance open source solutions for small- and medium-sized users. The EFM framework, developed and tested by DOT with Battelle, Booz Allen Hamilton, and SAIC, consisted of non-proprietary open network architectural specifications using UBL standards, publicly-available Web services, and a Service-Oriented Architecture (SOA). EFM focused on automated data exchange among supply chain partners over the Internet. Many-to-many data relationships were a key characteristic of EFM; they replaced more costly and incomplete one-to-one relationships.

The Columbus EFM project in 2007 was a successful, 6-month deployment test of Web services and automated data exchange in an air cargo supply chain of The Limited Brands (LB) from Guangdong province in southern China to Columbus, Ohio. Freight for two of the LB's business unit supply chains was trucked into Hong Kong, transported via air cargo charters to Rickenbacker Airport in Columbus, Ohio, and then trucked to LB's distribution centers in Columbus. While the test involved air cargo, the emphasis was on data exchanges and automated status reporting that could be applied to any and all modes as well as to other shippers and the 3PLs that performed logistics services for them. An independent evaluation of the Columbus test showed positive results for all supply chain partners involved, although there was no follow-on implementation of EFM by any of the test participants. Nevertheless, FHWA thought the results were successful enough to initiate several EFM pilots around the United States to assess the flexibility of the EFM package, promote adoption, and measure its benefits.⁶⁹

Columbus partners said the most important benefits may be for small- to medium-sized shippers and 3PLs who use fax, email, or telephone for the majority of their communications with their supply chain partners and who do not want to assume the costs associated with implementing existing data exchange formats such as EDI; the test partners said conducting the electronic data exchange via EFM should be less costly compared to EDI. The diagram below shows the interactions and data flows among EFM supply chain partners:

The diagram illustrates the EFM (Electronic Freight Management) system architecture. At the center is a circular hub labeled "EFM" containing "Internet Web Services SOA / Registry". This hub is connected to several external entities via a green circular ring representing data flow:

- Buyer / Seller** (top): Connected via "Partner Authorizations" and "PD Transportation Status".
- Back Office Integration** (top right): Represented by a laptop icon.
- Manufacturer 1-n** (right): Connected via "Booking and tendering Transportation Status".
- Freight Forwarder 1-n** (bottom right): Connected via "Transportation Status (Ex. Advanced Shipment Notice)".
- Customs Broker** (bottom): Connected via "Customs Clearance Status".
- Transportation Provider 1-n** (bottom left): Connected via "Transportation Status (ex. arrival and departure)".
- Terminal 1-n** (left): Connected via "Transportation Status (ex. arrival and departure)".
- Warehouse or Container Freight Station** (top left): Connected via "Transportation Status (Receipt and) dispatch".

The central hub also includes a label "Global Integration - Global Connectivity" around its perimeter.

The EFM Pilots

The EFM implementation case studies that were funded and kicked off in 2009 were intended to examine the degree to which the EFM applications could improve the operational efficiency within intermodal supply chains. Each case study documented the cost-effectiveness, long-term viability, and sustainability of the EFM package, as it was modified and implemented within the supply chain. Although contractor-led, the case study teams at SAIC and Battelle worked closely with the private sector entities to promote the commercial adoption and use of self-supporting EFM-related systems and services.

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- Kansas City SmartPort – DEMDACO
- Interdom Partners and Pride Logistics
- Interdom Partners and Agmark Logistics
- WorldWide Integrated Supply Chain Solution and Griffin Pipe Products Company
- Express Systems Intermodal, Inc.
- Fellowes (a simulation)
- “ACME,” an alias for a global supplier to the consumer products, electronics, and energy manufacturing industries (a simulation) conducted through Freightgate
- Carter Transportation LLC and Freightgate

For each case study, SAIC and Battelle worked with the various supply chain partners to implement the EFM package, which was initially developed by Battelle in Columbus EFM. The EFM package consists of three documents sets, targeted for specific audiences, as well as several software component bundles:

- The Adopter set is geared for a logistics person charged with evaluating the applicability of an EFM package to his or her needs.
- The deployment documentation provides specifics as to the infrastructure on which the package is deployed.
- The developer documentation details the software architecture of the EFM package and how one tailors it for one’s specific adoption.⁷¹

Benefits observed or calculated in the various case studies are discussed in the Benefits section below. Perhaps what is most important about two of the case studies is that the EFM implementation continued to be operated after the test. In the Interdom-Pride Logistics case study, Pride made EFM its long-term solution. It has changed the way Pride does business and the way Pride interacts with its customer (Interdom). Thus, the benefits will continue to accrue.

In the second example, Express Systems Intermodal (ESI) recognized that perhaps the most important qualitative benefit EFM could provide is a competitive advantage. ESI said that tools like the mobile app developed as part of its EFM pilot gave them an advantage in marketing to and securing new customers, as it offered an additional way to interact and complete transactions “on the fly” and at all hours. The EFM case study provided an opportunity for ESI to automate the invoice transaction with one of its more manual dray carriers, Hammer Express. The savings for this automation were so great that ESI intends to continue its use of the EFM package and pursue adoption of the automated invoicing with its second (also manual) dray carrier.

Cross-Town Improvement Project

Concerns about severe truck traffic delays around seaports and inland ports, general traffic congestion on urban highways and arterials, and negative regional effects related to air

quality, noise, and safety are pervasive. Freight delays themselves also have a negative economic impact on the private sector.

These issues have spurred considerable research toward identifying promising technological solutions to urban freight management. The FHWA Office of Freight Management and Operations (FHWA-OFM) has sponsored several research projects in this arena. In 2004, in conjunction with IFTWG, FHWA-OFM initiated the Cross-Town Improvement Project (C-TIP) in Kansas City. Kansas City is the second largest rail hub by tonnage in the nation after Chicago; it has significant volumes of cross-town intermodal handoffs by truck between western and eastern railroads, as well as local deliveries to industry.⁷² This activity requires cross-town dray truck trips between railheads and from intermodal terminals to shippers around the region. However, due to deficiencies in information sharing and business practices, the high volume also generates a significant amount of bobtail (a tractor without any container, chassis, or trailer) and chassis repositioning moves, which generate little or no revenue for carriers while contributing to congestion and other issues in the Kansas City region.

An initial C-TIP system was developed by SAIC following preparation of a concept of operations; the system was deployed in Kansas City for a four-month period from October 2010 through January 2011. C-TIP consisted of several functional components that included:

- A collaborative dispatch model (allowing freight railroads and dray carriers to easily identify load matching opportunities)
- An in-cab smart phone application that provided real-time traffic and routing information to dray truck drivers
- An Open Source Architecture Package (C-TIP OSAP) that provided dray dispatchers with real-time driver location data and a wireless communications platform for delivering work orders to drivers, allowing for easy identification of load matching opportunities and thereby reducing unproductive bobtails

More specifically, the following C-TIP subsystems or applications were developed and deployed:

Intermodal Exchange (IMEX) – An on-line “exchange” allowing the railroads, facility operators, and truckers to share information about available loads, delivery information, traffic, and scheduling

Wireless Drayage Updating (WDU) – A wireless communications system allowing carriers and their drivers the quick exchange of time-sensitive routing and shipment scheduling information

Real-Time Traffic Monitoring (RTTM) – Real-time traffic information for carriers to facilitate travel routing and scheduling decisions

Dynamic Route Guidance (DRG) – Real-time visual routing around congested areas using inputs from RTTM, a dedicated GIS source, and specially developed simulation tools

Cambridge Systematics (CS) conducted an independent evaluation in collaboration with RMI and Occur2Strategies. They designed the evaluation strategy to quantify the time savings and emissions associated with C-TIP, and also to assess non-quantitative factors such as software usability and overall viability in a commercial trucking environment. Additionally, two drayage optimization tests were conducted (one in Kansas City, the other in Chicago) to assess the potential for truck bobtail move reduction using wireless technologies within several of the C-TIP components. An intermodal optimization analysis using gate

move data between the CSX and UP railroads in Chicago determined the potential benefits of C-TIP IMEX in a much larger intermodal market. Table 1 shows the various elements of

C-TIP that were tested or simulated in Kansas City (and in one case, Chicago), along with a summary of the test results in terms of measured or calculated benefits.

Tabela 1. Elements of C-TIP Tested in Kansas City and Chicago

Test	Location	Dates of Test	Description of Test	C-TIP Module Deployed	Actual or Simulated	Test Results			Report Section
						Productivity Results	Emission Reductions ^b	Fuel Savings	
IKT Drayage Optimization	Kansas City, Missouri	6/28/2011 8/31/2011	Deployment of iPhones to optimize drayage moves	IMEX WDU	Actual	137 Bobtails Eliminated	1,721,823 grams	8%	Section 3.1
Pride Logistics Drayage Optimization ^a	Chicago, Illinois	8/1/2011 9/30/2011	Deployment of automated dispatching system with Android smart phones to optimize drayage moves	IMEX	Actual	30 Bobtails Eliminated	2,296,502 grams	52%	Section 3.2
Dynamic Route Guidance	Kansas City, Missouri	12/1/2010 4/30/2011	Deployment of RTTMDRG-enabled iPhones	IMEX WDU RTTM DRG	Actual	21% Travel Time Improvement	109,822 grams	10%	Section 2.2
Real-Time Traffic Monitoring	Kansas City, Missouri	12/1/2010 4/30/2011	Deployment of RTTMDRG-enabled iPhones	IMEX RTTM	Actual	19% Travel Time Improvement	54,300 grams	6%	Section 2.1
Kansas City IMEX Simulation	Kansas City, Missouri	10/1/2010 1/31/2011	Simulated matching cross-town railroad container moves	IMEX	Simulated	135 Empty Trips Eliminated	2,570,597 grams	8%	Section 2.3
Chicago IMEX Simulation	Chicago, Illinois	1/1/2011 4/30/2011	Simulated matching cross-town railroad container moves	IMEX	Simulated ^a	1,654 Empty Trips Eliminated	110,231,008 grams	17%	Section 2.3

Note: IMEX: Intermodal Move Exchange;
WDU: Wireless Drayage Updating;
RTTM: Real-Time Traffic Monitoring;
DRG: Dynamic Route Guidance.

^a Results assume three-hour delivery window.

^b Includes carbon monoxide, oxides of nitrogen, volatile organic compounds, carbon dioxide equivalents (greenhouse gases), particulate matter, and fine particulates.

Fonte: *Cross-Town Improvement Project Evaluation*, Cambridge Systematics for FHWA, 2012.

The initial deployment and benefits assessment of C-TIP technologies in Kansas City did prove the concept that such applications can provide public and private sector benefits, including congestion mitigation, emissions reductions, and truck travel time savings. Due to the scale of the test, the measured benefits were relatively modest. Nevertheless, it is reasonable to expect that much greater benefits could be achieved in

a larger intermodal

market like Chicago, where large scale cross-town container moves between rail yards occur on a daily basis. To assess this scalability, the C-TIP Evaluation implemented a Delphi assessment of a theoretical Chicago C-TIP deployment.

The results of the Delphi assessment revealed general agreement among intermodal industry experts that substantial benefits could be achieved. For example, panelists' expert consensus was that RTTM and DRG could achieve travel time savings of 5–10 percent per trip for Chicago cross-town dray movements, and that bobtails could be reduced by more than 15 percent per day.

In the end, C-TIP was a demonstration and test that was not implemented operationally. There were several operational constraints to full utilization of C-TIP in Kansas City. Although Kansas City was chosen for the test because it was a manageable-sized terminal compared with Chicago, getting enough companies to participate was difficult. The railroad and dray trucking industries generally do not collaborate or integrate their operations to the extent that would be required for a common dispatch platform to work. This contributed to the lack of railroad participation in the program, which necessitated a “what if” simulation analysis of the IMEX component.

The C-TIP evaluation report noted that the positive results obtained from DRG and RTTM in Kansas City (along with drayage optimization tests in Kansas City and Chicago) suggest that future research may be best targeted toward freight information exchange, improving the truck dispatch operation, and providing real-time information and tools to support truck routing decisions. The independent evaluator and FHWA believed that the use of C-TIP by the intermodal industry was more limited than expected, and that a key factor was the choice to take a government systems engineering approach to developing a system from the ground up. This approach, while technically sound, took several years to complete, by which time both the initial C-TIP industry champions and the smart phone and information technologies available in the marketplace had changed.

The C-TIP experience highlights an opportunity for future DOT tests to be based more on emerging applications being developed by the private sector. Mindful of the C-TIP experience, FHWA-OFM and the ITS Joint Program Office's Dynamic Mobility Applications program have built on the C-TIP experiences to develop the Freight Advanced Traveler Information System, as described in the next section.

Current Freight ITS Research and the Freight Advanced Traveler Information System

Dynamic Mobility Applications

The DOT Intelligent Transportation Systems Joint Program Office (ITS JPO) initiated the

Dynamic Mobility Applications (DMA) Program in 2009 as part of the Mobility program to

“expedite the development, testing, commercialization, and deployment of innovative mobility applications, fully leveraging both new technologies and Federal investment to transform transportation system management, to maximize the productivity of the system and enhance the mobility of individuals within the system.”⁷³

In 2011, the DMA Program concluded Phase I, which focused on data definition, technology application identification, and demonstration planning. The DMA Program began a second phase and partnered with the research community to further develop high-priority transformative concepts and to refine data and communications needs. One of these is the Freight Advanced Traveler Information System (FRATIS). DOT wishes to advance the FRATIS bundle from concept formulation (completed in Phase 1 of the DMA program) to prototype development and small-scale prototype testing (to be completed in Phase 2 of the DMA program) to test if the FRATIS bundle can be successfully prototyped and work as envisioned. Three small-scale prototypes were initiated in 2012 in Los Angeles, Dallas/Fort Worth, and South Florida, and an independent assessment contract was awarded for the prototypes and to estimate the impact of expanding FRATIS technology deployment to carriers throughout each of the three regions.

FRATIS

The FRATIS concept seeks innovations to transform freight mobility, including methods to:

- Leverage freight mobility information technologies under development in the private sector regarding freight traveler information, dynamic routing, and load matching
- Integrate these technologies with public sector ITS technologies and sensor information available for roadways in major metropolitan regions
- Facilitate accelerated public-private deployment of FRATIS applications

The first FRATIS component is the Freight-Specific Dynamic Travel Planning and Performance application and will include all of the traveler information, dynamic routing, and highway system performance monitoring elements identified in the development of user needs for the project. The FRATIS highway system performance monitoring capability will provide benefits to public agencies in terms of system management and can also supplement FHWA's Freight Performance Measures Program. The application will leverage

existing data in the public domain, as well as emerging private sector applications, to provide benefits to both sectors.⁷⁴

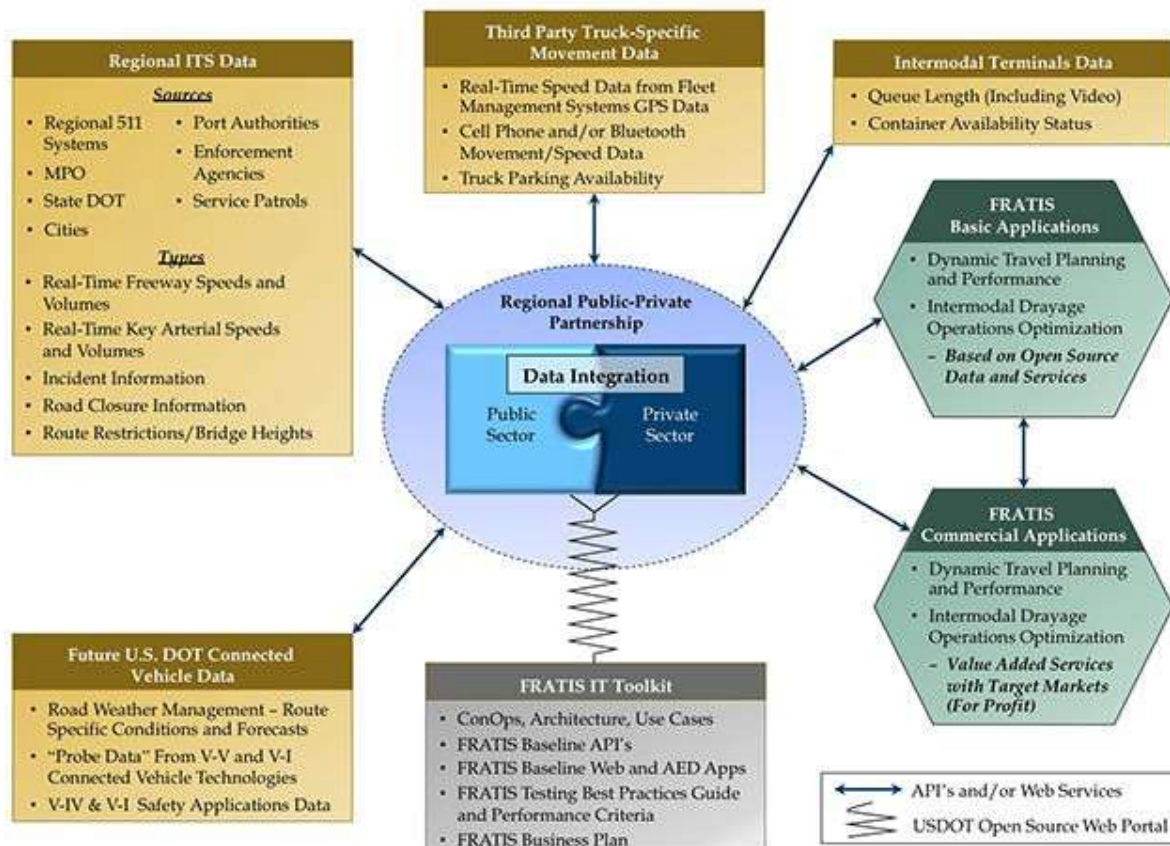
The second FRATIS component is the Intermodal Drayage Operations Optimization application that will combine container load matching and freight information exchange systems to optimize daily operations planning at motor carrier drayage companies, thereby minimizing bobtails and wasted miles and spreading out truck arrivals at intermodal terminals throughout the day. These improvements would lead to

corresponding benefits in terms of air quality and traffic congestion. The FRATIS prototype development efforts involve coordinated software development and system integration activities, including establishing connections with existing public (e.g., regional ITS) and private (e.g., terminal queue,

appointment times) sector systems. The impact assessment of the three prototypes involves analysis of the extent to which the small-scale prototypes contribute to the likelihood of expansion and use of the FRATIS applications by more, if not most, drayage companies in each region and beyond.

The Optimization Algorithm that will be used as part of FRATIS is under independent testing and assessment in Memphis. The diagram below shows the proposed integration of the travel information and optimization components. Development, testing, and assessment of the three FRATIS prototypes will be completed in early 2014.

Figure 4. The FRATIS Program



Fonte: USDOT ITS Program Office and Cambridge Systematics.

Commercial Vehicle Safety Research

Working together with the trucking industry, FMCSA conducts research into smart technologies that support the expanding role of the trucking industry to safely, securely, and efficiently transport the nation's goods and products.⁷⁵ The mission of FMCSA's Research Division is to reduce the number and severity of CMV-involved crashes and enhance the safety and efficiency of CMV operations by:

- Conducting systematic studies directed toward fuller scientific discovery, knowledge, or understanding

- Adopting, testing, and deploying innovative driver, carrier, vehicle, and roadside best practices and technologies
- Expanding the knowledge and portfolio of deployable technologies and innovations, which the Research Division will use to help FMCSA reduce crashes, injuries, and fatalities and use to deliver a program that contributes to a safe and secure commercial transportation system

Among the many research projects described on the FMCSA website, three in particular relate to Freight ITS research. Others can be reviewed at the website.

The **Integrated Vehicle-Based Safety Systems (IVBSS) initiative** seeks to establish a partnership with the automotive and commercial vehicle industries to accelerate the introduction of integrated vehicle-based safety systems into the nation's vehicle fleet. This is the first attempt to fully integrate the individual solutions that address three types of crashes: rear-end, road departure, and lane-change. The IVBSS will combine existing research results and state-of-the-art commercial products and product performance for all systems related to this problem.

The **Onboard Monitoring to Improve Commercial Motor Vehicle Safety effort** involves approximately 20 instrumented vehicles and approximately 40 drivers to determine whether onboard monitoring and feedback (real-time and delayed) can improve commercial motor vehicle driver performance and safety. If successful, the technology suite will provide driver performance feedback on a number of critical safety factors, including hours of service, lane keeping, steering and pedal inputs, safety belt usage, following distance, turn signal use, and hard braking and hard steering events.

Safety and Security Technology Deployment. Over the past several years, FMCSA has been involved in efforts to test, evaluate, and encourage the deployment of onboard safety and security systems, such as collision warning systems with adaptive cruise control, stability control systems, lane departure warning systems, and vehicle tracking systems. Through systematic deployment planning for onboard systems, FMCSA continues to be engaged in industry-government partnerships to conduct studies and relay information to promote commercial motor vehicle safety and security. FMCSA also continues to add new technologies to the Technology Product Guides on its website, which provides information about existing and emerging safety and security system technologies for the motor carrier industry. The purpose of this information is to assist carriers, drivers, fleet managers, and other interested individuals in learning more about available safety and security systems.⁷⁶

Benefits of ITS Freight Applications

Every section of Module 6 has touched on some benefits of ITS freight applications. This section pulls together some of the data and themes and adds cautionary words about “crossing the chasm” that separates a new technology’s potential benefits from the successful realization of those benefits.⁷⁷

The section focuses on benefits produced and documented by DOT's ITS and related programs, particularly since those programs include concerted efforts to measure and report actual or potential benefits. This section summarizes some of those benefits calculations, including the EFM projects, C-TIP, CVISN, and the benefits currently being analyzed in the FRATIS project.

As noted early in the module, private sector deployments of satellite-based asset tracking systems produced huge economic benefits for [leading-edge carriers](#). Private sector benefits, often regarded as proprietary information, are not as well documented and certainly less available than the independently-funded evaluations of projects with Federal participation. Nevertheless, the section also discusses industry improvements and some quantitative benefits.

The elements of this section are:

1. Columbus EFM Benefits
2. EFM Case Study Benefits
3. Industry Benefits Comparisons
4. C-TIP Benefits
5. FRATIS Transformative Benefits
6. Private Sector Benefits
7. CVISN Benefits
8. Catalytic and Critical Role of Effective Implementation

Columbus EFM Benefits

In the evaluation of Columbus Electronic Freight Management (CEFM) test data and interviews with Columbus partners, the evaluators estimated *administrative* cost savings related to having better and more complete data sooner, normalizing those savings to \$5.94 per air freight shipment unit, nominally at the purchase order level.⁷⁸ Because the manufacturer savings and some of the forwarder benefits reflected Chinese and Hong Kong labor rates, supply chains wholly within or between developed economies are likely to have higher dollar savings.

While the quantified savings in Columbus accrued primarily to the individual supply chain partners, there is a derivative benefit to the shipper or supply chain owner through the long- term use of visibility technologies: it is in the supply chain owner's interest for its partners to become more efficient. For example, more efficient manufacturers and freight forwarders can provide better service and may be able to reduce their rates to the shipper.

Table 2 shows individual metrics and results from the CEFM evaluation; CEFM's benefits came largely in labor savings and data quality improvements.

Tabela 2. Columbus Electronic Freight Management (CEFM) Benefits

Supply Chain Function	CEFM Benefits
Productivity:	
Shipping Documentation	♦ Reduced stakeholder data entry by 50-75%
Automated visibility data	♦ Improved data accuracy at freight station by 25%
Automated messaging	♦ Improved warehouse data availability by 10% ♦ Better staff planning and forecasting of workload
Service Quality	
Automated status data	♦ Improved number of shipments/week processed by Customs broker by 18% ♦ Reduced time to research priority shipments by 27 minutes/day
Data quality and availability:	
Frequency of data updates	♦ Eliminated most re-keying through near real-time data
Data accuracy	♦ Improved data accuracy by 25%
Data timeliness	♦ Improvement in data receipt by 6-72 hours

Fonte: Derived from Table 1, p. 9, *Columbus Electronic Freight Management Evaluation: Achieving Business Benefits with EFM Technologies*, DOT-ITS JPO, March 2009.

EFM Case Study Benefits

Table 3, extracted from DOT's report on eight EFM case studies, presents the benefit/cost ratio for each case study. The ratio compares the present value of the *measured* benefits and the present value of the total costs over the life of the project. (For a simple explanation of net present value, look [here](#).) A ratio of 1.0 means the project broke even; project supporters hope for results well above 1.0.

Six of eight projects demonstrated net benefits with ratios greater than 1.0. In addition, each project had unmeasured or immeasurable qualitative benefits, which cannot be reflected in a benefit/cost ratio. This means that the real value of each project to its users was probably better than the ratio.

Tabela 3. EFM Case Study Benefit/Cost Ratios

Case StudyBenefit/Cost Ratio	
Kansas City SmartPort – DEMDACO	2.49
WorldWide Integrated Supply Chain Solutions	7.33
Interdom Partners-Agmark	0.94
Interdom Partners-Pride	6.62
Express Systems Intermodal	0.96
Fellowes (Simulation)	18.39
Carter Transportation	1.36
ACME (Simulation)	127.15

Fonte: Adapted from the Executive Summary, *Electronic Freight Management Case Studies: A Summary of Results*, DOT Report, June 2012.

For the purpose of the *ePrimer*, let's look at the first case study; readers interested in more information can find it [here](#). In Kansas City, DEMDACO (the supply chain owner) was the principal beneficiary and estimated savings in three areas: reduction in outbound backorders by 30% because of better incoming inventory receipt information; increase in overseas shipping container space or cube utilization by nearly 4% through the use of EFM; and reduction in 10+2 filing fees by 50% with data elements provided by EFM. This analysis demonstrated substantial cost reductions driven by the improved inbound shipment delivery date information available from EFM.

Industry Benefits Comparisons

Industry research tells us that, while the web-based solutions are more accessible to small- and medium-sized companies because of lower start-up costs, fewer of these companies use the technologies, and most EFM benefits to date have accrued to large companies. An Aberdeen Research study noted that half of firms reporting quantified benefits were large firms.⁷⁹

Based on the case studies and industry research, the authors believe effective implementation of freight ITS including EFM and visibility technologies yields significant and lasting quantitative and qualitative benefits to companies of all sizes. Research shows that benefits grow with familiarity and experience; the Aberdeen survey found that the benefits

realized from visibility technologies increase the longer the solution is in place: they noted a marked increase after two years of a technology deployment—in other words, persistence pays dividends.

The EFM Initiative also shows the importance of benchmarking “before” or existing condition data for comparison with operations after implementation. Such before and after data are integral parts of the FRATIS prototype projects underway in 2013.

Major users of these technologies report better integration with their partners and greater supply chain visibility. Several users reported benefits of 20% reductions in transportation costs, 20% reductions in safety stocks, and 8–15% reductions in processing effort. The findings from individual firms’ reports and from industry surveys conducted by firms such as Capgemini and Aberdeen show that companies do benefit from implementation and use of visibility technologies.⁸⁰

The CEFM test concluded that integration of supply chain data into a company’s operating systems is crucial to achieving benefits. In addition, integration among multiple partners through EFM or other networks can directly impact key supply chain business goals in productivity, service quality, and shipment integrity. The Capgemini 2008 survey states that it is important to look at what “major players” are doing that is significantly different from everyone else. Two of the key traits of major players are *integration with their partners* and *greater visibility*, both benefits of these visibility technologies.

There are numerous web-based networks of commercial software providers that have hundreds or thousands of potential supply chain partners already interfaced with their networks. This helps to add new partners to an automated supply chain information exchange and helps with integration.

C-TIP Benefits

Table 1, Elements of [C-TIP Tested in Kansas City and Chicago](#), demonstrates the benefits of the C-TIP evaluation. Here is a summary C-TIP benefit types:⁸¹

- In Kansas City, 137 bobtail truck trips were eliminated, even as revenue loads remained stable.
- The automated dispatch system implemented at a Chicago-based carrier eliminated most of the manual effort from the dispatch operation and better-identified load matching opportunities. This helped eliminate 30 bobtails while the number of total loads grew.
- Out of 95 total trips on five intermodal lanes in Kansas City, the C-TIP component redirected trucks 30 times on three lanes, with travel-time savings of 5 to 7 minutes per trip. On average, travel times improved 21 percent.
- Through initial route recommendations at trip outset, RTTM saved drivers on one Kansas City intermodal lane an average of 6 minutes travel-time per trip, corresponding to a 19 percent reduction in travel time.

- Based on the traffic improvements identified in the Kansas City test, the evaluators computed 6 to 10 percent in emissions reductions.

The C-TIP evaluation contractor performed two simulations to demonstrate the likely impact of C-TIP expansion to more freight traffic. The simulations showed:

- The system could have eliminated 135 bobtail trips in Kansas City over a 4-month period, avoiding more than 1,000 empty truck-miles and saving 180 gallons of diesel fuel.
- If all stakeholders fully utilized C-TIP, the bobtail reduction would have reduced greenhouse gases by about 2.6 million grams and criteria pollutants by almost 19,000 grams.
- Based on gate move data between two railroads in Chicago, C-TIP could have matched 1,654 loads during a 4-month period, assuming a 3-hour cross-town delivery window. This would have saved 6,864 gallons of diesel fuel, with concomitant reductions in greenhouse gas and criteria pollutant emissions.

FRATIS Transformative Benefits

In the 2012 FRATIS Concept of Operations, the consulting team from Cambridge Systematics derived a set of goals and performance measures based on the results of a state-of-the-practice scan, Internet research, and the collective experience of the consultant team. Table 4 shows the performance measures and transformative targets for the FRATIS bundle of applications; these are the principal measures being used in the 2013 FRATIS prototype impact assessment.⁸²

Tabela 4. FRATIS Performance Measures and Transformative Targets

Performance Measures	Reduction Targets (%)		
	Near-term	Mid-term	Long-term
Number of bobtail trips	10	15	20
Terminal queue time	20	35	50
Travel time	15	17.5	50
Number of freight-involved incidents	30	35	40
Fuel consumption	5	10	15
Level of criteria pollutants	5	10	15
Level of greenhouse gas equivalents	5	10	15

Key: Near-term: next 5 years; Mid-term: 5-10 years out; Long-term: > 10 years

Fonte: *Assessment of Relevant Prior and Ongoing Research and Industry Practices, 2012.*

For improvements in travel time, reduced fuel consumption, and reduced emissions, the increasing benefit over time is assumed to result from incremental improvements in technology and user interfaces within each fleet that adopts FRATIS, regardless of overall market penetration (i.e., an adopting fleet will continue to improve over time, irrespective of FRATIS deployment by other fleets).

Bobtail reduction metrics are predicated on full coordination between participating truck fleets and terminal operators, because without such coordination, reducing unproductive truck trips becomes much harder. Finally, for reductions in terminal queue times, the incremental improvements assume improvements in queue detection systems as well as growing adoption of new methods of information delivery (such as smart phones).

Although it is difficult to quantify, the use of FRATIS data about traffic conditions and its enhanced dynamic routing capability should allow trucks to make routing decisions that decrease the likelihood of crashes. Particularly if hazardous cargoes are involved, using up-to-date and accurate ITS information to find a safer route can have a public benefit as well as improved safety for the driver and cargo. FRATIS hopes to yield such improvements.

While it is too early to include actual FRATIS results in this module, these benefits are indicative of the kinds of improvements that have been—and are likely to be—experienced from implementation of Freight ITS.

Private Sector Benefits

Unlike the public-private tests described above, private sector companies rarely report their own benefit accomplishments. However, the trade press has some information about benefits of freight information technologies.⁸³

- As discussed in the Introduction, the first vehicle tracking system adopted exceeded all of the carriers' goals, yielding significant benefits in operating efficiencies, customer service, driver satisfaction, and truck maintenance management. As a result of tying the satellite tracking data with customer shipment requests and other information, expense ratios dropped, empty mile percents plummeted, and driver turnover shrank. In addition, customers noticed the difference in the quality and reliability of the carriers' services.
- Benefits identified from using real-time data and asset tracking were:⁸⁴
 - RFID-enabled Real Time Location Systems (RTLS) linked to Yard Management Systems (YMS) increased moves per hour from 5 to 12
 - 30–50% reduction in switcher labor and switch cabs in yard
 - 25–30% reduction in gate processing personnel

Tracking every trailer allowed better inventory management. “If you have real-time accurate data, shared among shipper, carrier, and consignee, on when a trailer started loading, when it left the facility, and you know the drive time, then you will know when it will arrive and can unload quickly and release it quickly.”⁸⁵

- Automation of route planning, route accounting, and customer delivery records helped improve the efficiency of supplier operations and generated benefits such as fewer administrative errors, improved order management, increased sales, improved productivity, shorter billing cycles, and fewer returns.

CVISN Benefits

HELP PrePass, the largest public-private CVO partnership, began operating in 1997. HELP, Inc., continually measures and estimates annual benefits for states, carriers, and the environment. Table 5 shows the cumulative results and is illustrative of the kinds of benefits that have occurred or are expected with CVISN. HELP, Inc., categorizes the number of bypasses as a State benefit, reflected in inspector labor redirected to carriers and loads with poorer safety or weight indicators. Driving hours, gallons of fuel, and dollars are carrier benefits, based on saving 5 minutes, 0.4 gallons of fuel, and \$5 per pull-in. Metric tons of carbon emissions are the environmental benefit generated by avoided idling at inspection sites plus an avoided acceleration cycle upon a truck’s departure.⁸⁶

Table 5. Cumulative Benefits from PrePass Inspection Bypasses, 1997-2012

No. of Bypasses	522,471,210
Driving Hours Saved	43,882,008
Dollars Saved	\$2,626,328,465
Gallons of Fuel Saved	210,633,637
Reduced Emissions*	121,877,158

*Carbon monoxide emission reductions calculated in metric tons

Fonte: Adapted from the PrePass website, which has the [latest information](#). Provided by: HELP, Inc. – Provider of PrePass.

Catalytic and Critical Role of Effective Implementation

Great technology does not guarantee great benefits—in fact, it cannot guarantee *any* benefits. Absent user management vision and skill, new technology benefits can be wasted. An unaware, unwilling, or botched deployment means no business benefits. The box below offers a dramatic real-world example.

A Cautionary Tale for New ITS Technology Benefits

In “[Background on Freight ITS](#),” we describe how truckload carrier adoption of satellite-based fleet location and communications produced huge benefits for some carriers. Our example was based on Schneider National in its pioneering success with Qualcomm’s OmniTRACS service. (Company and product names are used to add vibrancy to the points made; of course, neither

DOT nor this report

endorses specific products and services).

The adoption of OmniTRACS also illustrated a sobering truth: if you do not effectively implement and deploy technology, you will not achieve any business benefits. OmniTRACS' ITS capabilities were *necessary* for Schneider to realize those benefits, but those capabilities were *not sufficient* to achieve the benefits. First, a user management team must have the vision and awareness to see the potential for the new capabilities. Second, those managers and their IT and operating teams have to apply implementation and deployment skills and resources to field the innovation and capture its benefits.

Let's contrast Schneider's success with another carrier's unaware and unproductive deployment of the same technology. Truckload carriers of munitions and explosives were early adopters of OmniTRACS. However, unlike Schneider and others, the munitions carriers adopted OmniTRACS because DOD paid a premium rate of one cent per ton-mile for use of an OmniTRACS-like capability. DOD paid the premium for better safety and security for ammunition and explosives shipments. (We discussed the Defense Transportation Tracking System [here](#).)

One major munitions carrier used OmniTRACS for several years before it either recognized or captured the potential inherent in that ITS system. In 1992, a senior executive of the carrier described the satellite system to one of the authors as "OK," as "another box on the dispatcher's desk," and as a success because it generated an extra penny a mile. About five years later, the same executive commented repeatedly on the significant operating benefits that the carrier realized by integrating the satellite-sourced data stream with other management systems. In other words, that munitions carrier lost several years' worth of significant benefits before its leaders "got it." ⁸⁷

Failure to exploit good technology can happen in sponsored freight ITS programs. For example, despite the quantitative benefits documented in the CEFM program, the participants did not continue to use the system after the test ended—the issues were institutional, not technical.

Kansas City EFM with DEMDACO was similar. The test ended and the participants went back to operating as they had before. The better news, though, was that DEMDACO planned to implement within two years of test completion. In C-TIP, the Kansas City participants did not implement despite well-articulated analysis of what *could* happen if the implementation were expanded to more traffic and other companies.

As noted above, two of the eight EFM case studies resulted in companies actually changing their operations and applying the positive results and improvements with more of its partners. In the other EFM case studies, there was no follow-on implementation.

More generally, another reason to be cautious about realizing tangible benefits from ITS freight applications is that many segments of the freight industry are characteristically slow to adopt successful IT system innovations. A long-time, respected observer of the freight transportation scene believes three major problems "are pervasive in the

transportation industry: sluggish adoption of [new] IT systems, selection of systems that are neither

interoperable nor easy to use, and the failure of [transportation] providers...to reengineer core processes.”⁸⁸

One final note of caution: effective implementation is necessary but not sufficient to achieve sustained business benefits from new technology. Technology requires maintenance and preservation; new technologies often complicate matters by requiring new approaches to and systems of preventive and curative maintenance. An effective maintenance culture is essential.

Our goal in sharing these cautionary remarks is not to discourage innovation but to encourage attention to institutional and deployment issues for ITS freight—and other—innovations. In fairness, each ITS project yielded important lessons that have been applied in future projects. FRATIS, for example, includes a comprehensive analysis of the potential impact of widespread implementation of FRATIS technologies. In order to facilitate and encourage implementation, DOT and its contractors are paying special attention to the deployment issues by emphasizing stakeholder coordination in the regional areas.

Future Directions of ITS Freight Research

Vehicle-to-Vehicle and Vehicle-to-Infrastructure Research for Heavy Truck Safety

We believe that Vehicle-to-Vehicle (V2V) and Vehicle-to-Infrastructure (V2I) research will be important, continuing themes for CVO safety research. In the latest data, 10% of all fatal vehicle crashes involved a heavy truck, and effective V2V and V2I deployments promise to reduce the number and severity of such crashes. For example, the V2V Truck Safety Program is addressing Forward Collision Warning, Blind Spot/Lane Change Warning, Intersection Movement Assists, and Electronic Emergency Brake Lights. The V2I program is addressing Curve Speed Warning and in-cab Low Bridge Clearance Warning. FMCSA’s Wireless Road Inspection (WRI) research program also is addressing aspects of V2I issues in truck safety. The Commercial Vehicle Retrofit Safety Device Program is addressing issues of economic and practical solutions for the significant existing fleets of heavy vehicles.⁸⁹

Technical solutions are useless unless they provide data-supported benefits clearly in excess of user costs. Beyond the economics, solutions must be robust and appropriate to transportation operating environments; that requires careful consideration of human factor and institutional considerations. In addition, solutions for new builds and retrofits must be viable commercial products for manufacturers, original equipment manufacturers, operators, and maintenance programs. Happily, the DOT programs aim to “accelerate the development and commercialization of commercial vehicle technologies based on V2V and V2I wireless communication using DSRC technology.”⁹⁰

In general, automotive V2V and V2I programs are more advanced than the heavy truck sector. This reflects both the economies of scale available via the vastly larger

fleets of

private cars and the *relatively* lower complexity of intervening in the operation of a sedan vs. an 18-wheeler.

A watershed event should occur in 2014: DOT's NHTSA will consider, for the first time in a regulatory context, the technical maturity and economic trade-offs of truck V2V and V2I safety technologies. Possible outcomes range from a mandate to deploy certain solutions in future truck models to encouraging voluntary implementation of such solutions to calling for further research. Given the stringent requirements imposed by operating efficacy, possible unintended consequences, and legitimate liability concerns, the authors believe robust research will continue for some time.⁹¹

In 2000, the editors of *Transport Technology Today* asked, "Are Trucks Getting Too Smart?" They observed that "[m]anufacturers and government agencies have been brainstorming for years about how to make trucks smarter with innovative technology meant to save lives, time, and money." However, these efforts might be counterproductive, "creating a cacophony of bells and whistles... [that] detracts from...driving the truck."⁹² Although the editors did not have today's term for such a phenomenon ("distracted driving"), it was the essence of their concern. DOT's V2V Truck Safety Program appears to be addressing such concerns with instrumented pilots using actual commercial drivers.⁹³

As part of its Safety and Security Technology Deployment, in the future, FMCSA plans to perform expanded testing and evaluations of current and next-generation onboard safety systems to identify and resolve technology adoption issues, confirm and extrapolate safety and productivity benefits to the broader industry, and develop focused deployment efforts to promote expanded adoption of the systems by industry.⁹⁴

Future Freight Data Management

Supply Chain Digest (news@scdigest.com) publishes annual predictions, including some from supply chain analysts at firms like Gartner and IDC Manufacturing Insights.⁹⁵

In its 2013 expectations for future development and implementation of logistics practices and technologies, Gartner analysts say that achieving high levels of supply chain visibility will continue to be a challenge. Even by 2016, they predict fewer than 20% of companies will have achieved end-to-end supply chain visibility. This is in part because the number of touch points in the supply chain is increasingly complex. While some companies have shown significant return on investment (ROI) from visibility investments, others have trouble making the business case. Some software vendors claim to provide full end-to-end visibility, although Gartner believes that is not the case. Certain shippers, such as DOD, need end-to-end visibility, whereas some retail companies need less. Parcel carriers such as UPS and FedEx are likely to continue improving their supply chain visibility by making more and more shipment status data available on their websites. W.W. Grainger expects supply chain software providers and consultants to work on enhanced connectivity to

and collaboration with suppliers in order to improve performance in the supply chain; the challenge—and goal—is to achieve transparency, visibility, and collaboration.⁹⁶

The analysts expect continued growth in making software products available over the Web. Gartner predicts that by 2016, more than 40% of new logistics application purchases will be delivered through cloud-based software solutions. In areas like Warehouse Management Systems (WMS) and Transportation Management Systems (TMS), cloud-based or Software-as-a-Service (SAAS) software offerings typically have had less functionality than traditional "on-premise" software; this has been a barrier to adoption for companies with more complex logistics needs. However, cloud or supply chain management software vendors "continue to enhance their applications by adding more functionality," and "they will soon be viable offerings for even complex and sophisticated logistics organizations." Gartner expects cloud solutions to grow but not wholly replace on-premise solutions for at least several years. "Rather, they will complement and co-exist with traditional enterprise applications."

IDC Manufacturing Insights predicts that resiliency will become an even higher priority for manufacturers. Demand will continue to be volatile, supply chains will be more complex, and the supply chain owner will need to be responsive and resilient. This puts pressure on data management systems and analytics for managing global supply chains. "Supply chain resiliency is about both better managing inputs from the demand side of the supply chain and being more responsive on the supply side," IDC says.

There will be improvements and research opportunities in analyzing supply chain data. Hoping to leverage the vast amounts of supply chain-related data, the field of predictive analytics will grow with more research into optimization for routing and supply chain operations. Lora Cecere, founder of Supply Chain Insights, reinforced the predictions in the same issue of Supply Chain Digest: "Satisfaction with transportation and warehouse management applications is high, while satisfaction with planning software is low. As a result, there will be a new growth for Best-of-Breed planning solutions."

Dynamic Mobility Applications

As observed in the DMA concept development documents, application bundles may work cooperatively to increase impact and reduce costs.⁹⁷ For example, there may be synergies linking data regarding traveler intent and possible decisions from IDTO, FRATIS, and EnableATIS with system management bundles such as R.E.S.C.U.M.E, INFLO, M-ISIG, and Next-Gen ICM. A team will build a simulation-based regional modeling capability to examine the potential for cross-bundle coordination and enhanced application impacts. These analyses can estimate impacts and identify promising system-coordination concepts to the prototyping efforts.

The Research Data Exchange (RDE) serves as a portal facilitating access to archived and real-time data feeds related to DMA applications and developments. These capabilities can help coordinate data for tool development, prototype development, and sharing model outputs for impacts assessment. For example, RDE should make data

from demonstrations and cross-cutting tests available to tool developers. A tool developer could access test

results and better model the latency and reliability of competing communication modes. Further, RDE could house outputs from the enhanced analytical tool based on field test data. Other researchers could refine their impact estimates based on simulation outputs.

The prototype RDE went live in May 2012. Phase 2 and Phase 3 of the Data Capture and Management (DCM) program include successive RDE releases with new data sets and functionality.

Natural Gas Truck Engines and Infrastructure

In the near future, given the increasing supply and reduced price of U.S.-sourced natural gas, research is likely to facilitate expanded use of natural gas engines in over-the-road trucks. Research would include environmental impacts of wider transportation use of natural gas, including the impacts of infrastructure needs for filling stations and maintenance facilities—and the use of ITS tools to facilitate smooth and effective transition to mixed fleets and infrastructure.⁹⁸

On-Board Technologies

Trucks must have Electronic On-Board Recorders (EOBR) beginning in 2015. Among other data elements, on-board recording devices capture data about engine performance, including fuel economy. EOBR research likely will address the safety and truck technical data to meet DOT requirements, improve truck efficiency, and reduce environmental impacts.

Research will continue on in-cab improvements, especially audio and other systems to prevent or mitigate distracted driving. Software vendors are creating new mobile applications to take advantage of smart phones, tablet computers, and other in-cab devices. Likely applications include facilitating hours-of-service compliance, electronic vehicle inspections, and commercial navigation focused on truck-friendly routes, such as routes without low bridges.

Freight Shuttle and Other Advanced Technologies

Texas Transportation Institute developed the Freight Shuttle concept as a low-emission alternative to move freight and relieve congestion in heavy freight/travel corridors. The Freight Shuttle would move conventional truck trailers and containers via automated transporters on dedicated guideways in highway medians or other rights-of-way.

Emission-

free, electric-powered guideway systems would accommodate shipments of up to 500 miles. The guideways and transporter modules are reminiscent of people-movers/monorails at airports. Animations on the [website](#) illustrate the transporters, guideways, and container loading process.

Private investors formed Freight Shuttle International (FSI) to pursue the research. The company points out that “there is no new ‘gee whiz’ technology involved” and says that the privately funded Freight Shuttle is based on a patented application of existing technologies. The company says it would save more than 25% to move freight

compared with

conventional trucking. The separate guideway would enhance safety, because passenger cars and pedestrians would not interact with the system. Transporters would travel quietly at slightly more than 60 mph with 10 second intervals.⁹⁹ More information is available at FreightShuttle.com.

In early 2013, the cities of El Paso, TX, and Juarez, Mexico, signed a letter of agreement with FSI to build an approximately 20-mile system between secure terminals on either side of the border. In this application, the specific goal is to relieve congestion at the border crossing and allow greater throughput. The developer at FSI sees this particular application

as serving existing, over-the-road trucking customers and logistics companies. Not everyone agrees that a system on new guideways is the best way to solve what they view as a

process issue. Nevertheless, the proponents hope to be operational by 2017.¹⁰⁰

Another example of private advanced system freight transportation research involves a self-propelled ocean container, the Autonomous Sustainment Cargo Container, also known as Sea Truck. The Sea Truck system has a propulsion module and bow module. Both attach to existing commercial cargo containers. There have been successful demonstrations of on-board control and steering by the developer, Aeplog Inc.

Reportedly, U.S. military has some interest in Sea Truck. The company website has at least seven demonstration videos (visit

[SeaTruck](#)).¹⁰¹

Resumo

This module explains the differing yet complementary goals and technology strategies of private and public sector ITS freight applications. It describes examples of ITS freight applications and the benefits delivered to stakeholders. Sections highlight industry- and government-led efforts to test and deploy ITS technologies; they highlight government-funded projects that assessed technologies and catalyzed freight-related industry productivity gains. An underlying theme is that the public and private sectors have found new synergies using similar technologies for different purposes.

Efficient freight transportation of domestic and international shipments of raw materials, intermediate, and finished goods is vital to the U.S. and world economies. Many freight transportation firms, focused on efficiency and profitability, have used the latest in communications and information technologies including GPS, RFID, on-board computers, mobile communications, and data exchange systems; public sector freight-related initiatives used overlapping technologies to enhance safety regulation and compliance.

More than 20 years ago, long-haul truckload carriers achieved near-revolutionary improvements with on-board computers and sensors tied to satellite-based location determination and communications systems. Public agencies and consortia such as

PrePass and NORPASS began to enhance CVO compliance and facilitation, pairing on-board RFID transponders with remote databases through weigh and inspection stations.

DOT agencies (including FMCSA, FHWA, and the ITS JPO) work together with the trucking industry to research and assess smart technologies that can help carriers safely, securely, and efficiently transport the nation's freight. The September 11, 2001, attacks heightened awareness among transportation professionals about threats that might turn transportation assets into vectors for attacks. DHS agencies established electronic data requirements as preconditions for ocean and air freight imports.

DOT's cooperative industry-based ITS freight-related research is a catalyst: it accelerates industry's ability to become more efficient and effective, and it enables public agencies to improve safety and regulatory compliance while lessening burdens, especially on the safest and most compliant firms. DOT incentivizes wider ITS technology exploration and use through programs such as FRATIS, DMA, Smart Roadside, and Virtual Weigh Stations. To help assure success of these programs, the private and public sectors work together through industry planning groups and region-based freight planning task forces.

DOT freight ITS initiatives promoted electronic data exchange and sharing among logistics partners with different systems and objectives. Projects such as EFM, C-TIP, and FRATIS provide auditable benefits and lessons-learned that can help ITS technology become part of the culture in freight transportation. Although most tested initiatives ceased operations when DOT funding ended, participating transportation companies implemented two of the EFM case studies and changed the way they operate. Overall, the test-driven benefits calculations show that the continuing freight and intermodal use of ITS technologies improves freight transportation. Freight-related ITS helps the private firms that transport cargo, the State and Federal agencies that regulate safety, and the Federal agencies that ship and manage large amounts of freight.

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